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A Veteran Honored

ENGINEERS will view with satisfaction, the Engineering Record believes, the elevation this week to the presidency of the American Society of Mechanical Engineers of that lovable gentleman and accomplished scientist, Dr. John A. Brashear, of Pittsburgh. The honor comes to him in the fulness of years—he is 74 now—yet it finds him with undiminished enthusiasm, with his interest in the well-being of those about him and in his work still active. Truly he is fit for the leadership of a great society, and well may he be an inspiration to both young and old in its membership.

Task Work in Cleaning Filters

TASK work in cleaning the sand in the filters of the Philadelphia waterworks has been responsible for a 15 per cent increase in the output of the force. This result, which is discussed in a paper by Sanford E. Thompson on page 608, is particularly interesting in view of the fact that certain city ordinances made it impossible to give the men bonuses for work done in excess of a specified amount. As the result of preliminary time studies definite areas of filter sand were marked off for each gang daily, the limits being fixed by flags. Although the system was met with opposition on the part of the men at first their antagonism disappeared as the work progressed. If it had been possible to reward the gangs in proportion to their accomplishments it is predicted that the efficiency would have been increased 50 per cent. In any organization governed strictly by civil service requirements the benefits to be derived from a bonus system are not easily realized. This is one of the reasons why private corporations are generally able to do work cheaper than municipalities. The Philadelphia results, however, indicate some of the possibilities of planning work in advance and setting a schedule of performances expected on city work.

Honor to Whom It Is Due

NO engineer can read without a feeling of satisfaction the address by Mr. Daniels, of the Interstate Commerce Commission, printed on page 623 of this issue. Engineers are frequently led to protest against the failure of the business world to accord them their proper position, though they are not always ready to admit that the engineer himself is largely at fault for his failure to secure recognition. Nevertheless, it is a fact that, in general, he is not accorded the place which his training fits him to fill. It is all the more gratifying, therefore, to read the unstinted praise of the profession by Mr. Daniels. Nor is his commendation based on generalities. He points out specifically his reasons for faith in the ability of the engineer to solve the difficult problems involved in the relations of public utility corporations to the public. It is interesting to note, too, the opportunity for high service to the community which Mr. Daniels sees in engineering work. To engineers their field generally looks prosaic. It is made up and bounded by formulas, figures and facts. A mind untrammeled by the technical limitations of the profession is needed in order to see the broader field and to appreciate that while dealing with facts and figures engineers have consciously or unconsciously gone far afield and allowed social considerations to enter into the solution of their problems. For his appreciation of their work, their high-minded attitude in approaching their tasks, and for the broad view he has taken of the opportunities of engineers, the profession is indebted to Mr. Daniels.

The Competition of Incompetence

THE address by Mr. Wheeler before the National Implement and Vehicle Association is commented upon elsewhere in these columns. One striking paragraph of his address deserves special mention. Speaking of the probable activities of the Federal Trade Commission, he asks how much recognition has been given by the government to the "competition of incompetence." While it would appear on the surface that an industry incompetently handled would eliminate itself and, therefore, constitute no menace, he holds that so long as it keeps afloat one incompetent unit in a business will exercise a disturbing influence upon all competing units. "The menace of incompetence," he states, "is not vicious but ignorant; nevertheless, the man who, through ignorance of his costs, throws a loss upon an entire trade, is just as guilty of misdemeanor as the man who deliberately depresses prices for the sole purpose of driving out competition and only by the cooperation of practical business can the [Federal Trade] Commission, seeking to render a public service jointly with the Department of Commerce, devise a means for lessening ignorance and thus largely eliminating what to my mind is one of the most dangerous forms of present competition." This view will probably strike many as being radical, but those who have had to meet this sort of competition realize that it is just as dangerous as that which is inhibited by the Sherman Act and the later supplementary measure. Its rectification must be expected as a result of the education of industrial executives rather than through governmental supervision.

Navigable River Fetich

THE navigable river fetich has been dignified with so much editorial space in this country that little new seems possible. Nevertheless there is a lawsuit in progress now in Chicago between property owners on a creek, which would probably be dry most of the year except for the sewage entering it, and the Sanitary District of Chicago. An injunction is being sought to prevent the latter from building a sewer straight across the stream. If there is any surplus water during storms after the sewer takes away the sewage and incidental drainage it is to be carried under the sewer by an inverted culvert for the creek, a perfectly normal procedure when the relative sizes and uses are taken into consideration. The creek is crossed by any number of railroad trestles and other obstruction in the vicinity, so that by no stretch of the imagination can river traffic negotiate the stream at present. Most of the river traffic, in fact, is by canoes. Still there is a fight to magnify its importance by calling it a navigable stream with a rosy commercial waterfront future. Circulars have been passed around asking every taxpayer in the city of Chicago whose interests are threatened to contribute liberally to the legal war chest. There is altogether too much maudlin enthusiasm over the importance of insignificant waterways in this country. We have so many real streams with real possibilities that it is misdirected public enterprise to spend energy on creeks.

Railroad Tunneling by a New Method

NEW methods of carrying out construction work are usually tried out by one means or another before being applied boldly to construction of an expensive character, but when the Rogers Pass tunnel was planned a scheme was proposed for which there was no precedent and whose very nature precluded the possibility of experiment. Not a little credit, therefore, is due those who developed the idea of using a "pioneer tunnel" as a means of shortening the construction period, and then entered into a $10,000,000 contract, depending upon this method to complete the work on time. Time is an important factor in most engineering construction, but it is unusual for it to play such an important part as in the work at Rogers Pass. After walking into the pioneer heading, now something over a mile from the portal, it is hard to realize that five times this length of continuous excavation in solid rock is being made at the expense of the contractors for the sole purpose of shortening the construction period by a period of several months. However, a consideration of the advantages of the pioneer method, as outlined on page 604 of this issue, makes it clear that, with the proper organization of forces, considerable time can thus be saved. The determination of the economy of this extra expense then becomes a question of balancing the additional cost against the saving which the earlier use of the completed tunnel will effect. Some of the items making up this total saving can be readily listed, such as the $100,000 per year maintenance for the 4 miles of snow sheds, and the cost of pusher service in handling the freight tonnage over the higher summit; while the amounts for other items, such as the insurance against accidents to trains caused by snowslides, and the elimination of destruction of snow sheds by fire in summer, can only be estimated.

There is no longer any question of the success of the pioneer bore method, for muck from 3000 ft. of center heading has been handled through a crosscut and out the pioneer portal, and this to the great advantage of work in the main portal. It will, therefore, be highly interesting to follow progress reports on this work, and to note the success of those features of the contractor's equipment and plans which are departures from usual practice.

Hauling Road Materials

ON page 621 are given the experiences of two road contractors in moving materials for two roads on the eastern shore of Maryland. One hauled with a small railway equipment for 10½ cents per ton-mile, exclusive of loading cost, and the other, using motor trucks, kept the unit price to 6 cents. Although to the casual observer the conditions seem similar, yet it would be absurd to attempt to demonstrate from these experiences the superiority of the motor truck for such work. Where the trucks found such advantageous use the problem involved moving crushed stone only, a 24-hr. schedule was usually possible, and the contractor had opportunity to use his trucks for other purposes during the winter. The other road builder found it necessary to work one shift only and to use extra labor because of local conditions, and on account of the short useful season depreciation looms comparatively large in the total. It seems, however, that in each case the equipment was well chosen, a very important consideration when one reflects that as much as 10 per cent of the cost of the road may go to handling material.

There is a great opportunity for education in this phase of road building. If a contractor said, for instance, that trucks on a short haul were operated for 36 cents per ton-mile, the man familiar with hauling conditions would probably answer that a chain of laborers with wheelbarrows would be more economical; and there are cases where the substitution would be appropriate. The road contractor, then, should look into the problem more closely, so that he may discover where the horse and wagon supersede the wheelbarrow, where the motor truck or trailer train supersedes the horse and wagon, and so on. He should be in position to realize that no one of these methods is obsolete and no one most efficient for the majority of cases. He should, in a word, realize the great advantage of using his own judgment in the treatment of this most important division of his work.

That many road builders do not keep this fact in mind is shown by their unwillingness to give publicity to hauling data, taking the stand that they are not required to make common property of a system successfully operated. Study of the two articles in this issue will indicate the fallacy of this narrowminded view of a question on which so little comparative information is to be had. The Engineering Record believes that road builders as a class will find it to their interest to give publicity to their experiences.

Appraising the Human Element in Industry

HUMAN frailty is such that few of us are able to follow with thoroughness more than one line of work or to keep up our interest in more than two or three activities not connected with our immediate employment. Consequently it is necessary to halt occasionally for an inventory, as it were, of those activities in which we should display some interest. If such were not the case this journal would not be warranted in referring so frequently to the necessity of carefully considering the human factors in industrial problems. Engrossed in outputs, materials, equipment and processes, the engineer is likely to forget how important a factor the human material, through which his results are accomplished, is in the ultimate success of his plans. For that reason engineers can read with profit the presidential address of James Hartness before the American Society of Mechanical Engineers this week. He calls it "The Human Element—the Key to Economic Problems." Many of the things he says have been said before but he brings home his points well and briefly.

One of his suggestions brings out his whole thesis emphatically. He urges that the investor and the promoter, in addition to demanding treasurer's report on an industry in which they may be interested, should also require a "human report"—a report to begin with a description of the directors of the company and go through the entire organization. Mr. Hartness can best tell what such a report should be. "This report," he says, "would contain a statement regarding the elements of harmony of organization; of lengths of service of manager and workers; the frequency of change of methods or articles manufactured; intelligence of executives in the management of men; the degree of contentment of each member; the extent to which each man in the organization approaches the best position for which he is endowed and how nearly he obtains the best remuneration for which he is qualified; the extent to which the management recognizes the inertia of habits of both mind and body; the degree in which the various men in the organization approximate the condition of highest efficiency; the extent to which the management goes in expression of appreciation; the degree of its knowledge of the most important characteristics of man as indicated by his inner motives and desires and the condition of his mind as he goes to his home at night." Mr. Hartness makes no mention of the condition of buildings from the points of sanitation and comfort, because, in his judgment, such conditions are now closely scanned. The points he mentioned are those which he believes must some day be measured just as we now measure power and other less vital things.

Continuing, Mr. Hartness says: "All of these elements should be carefully appraised and the average should be the rating of the company. The investor who considers this human rating with the treasurer's statement will seldom make a mistake in estimating the true worth of an industrial organization."

With this conclusion the Engineering Record believes all will agree. That corporations will accept the idea to the extent of applying it is not likely, but certainly in his admirable summary Mr. Hartness has laid down a rule of corporation conduct which, if applied, should immeasurably increase the efficiency of the average organization. Even if, therefore, his proposal of a "human report" is not accepted in its fulness it may well be held before executives as an ideal toward which their efforts should be directed.

Responsibilities of Public Service Commissioners

WHETHER or not public service commissioners shall give their entire time to their official duties is a question of broad interest which has been raised in Massachusetts by the resignation of George W. Anderson from the transportation regulatory board. In a letter to the Governor the retiring commissioner discusses the limitations of the law requiring members of the board to give their entire working time to their official duties and contends that the result is that the State does not secure the services of the best men for a sufficiently long period to yield the most efficient regulation. The tendency of the law is to confine membership upon the board to men of independent wealth or to those whose demonstrated earning capacity is less than the official salary.

In Mr. Anderson's opinion the former class of men is likely to be too much in sympathy with the utility companies for the best results, while the latter, being dependent upon their official salaries for their livelihood, are handicapped by the problem of reappointment. Municipal and State officials appreciate the latter difficulty, which is often rendered acute in this country by political conditions. But after all the real problem is that of the needs of the work rather than the hours in which it shall be performed. There is no question that in some states the public utility commissions are so far behind in the disposition of cases that the general welfare and that of the companies regulated alike demand the constant application of the members of such boards. This can best be secured by a long term of office, removed as far as possible from political assault. Such a condition is far more influential in its appeal to the best men than the question of salary, for in practically every case men of the ability described by Mr. Anderson accept government appointments at large personal financial sacrifices. Without trespassing upon the question of what is a suitable compensation for any class of public officials one may well agree with Mr. Anderson that the present Massachusetts policy "magnifies the importance of clerkly observance of office hours and minimizes the importance of vision, of sense of public need and public right, of independence of control of financial interests. It disregards the vital distinction between places in which mediocre administrative fidelity is the essential and places which call for the best there is in our best men."

No better example of a problem whose solution depends more upon local conditions could be cited. If the work of a public board is delayed through the part-time service of its members, something is clearly wrong. If it progresses steadily toward sound conclusions it would seem most unwise to hold officials of such a grade down to routine conceptions of their duties which preclude the use of spare time in other fields. Another five years of commission regulation will do much to establish the limitations which encompass this important and interesting branch of public service.

Constitutional Safeguards and Governmental Control

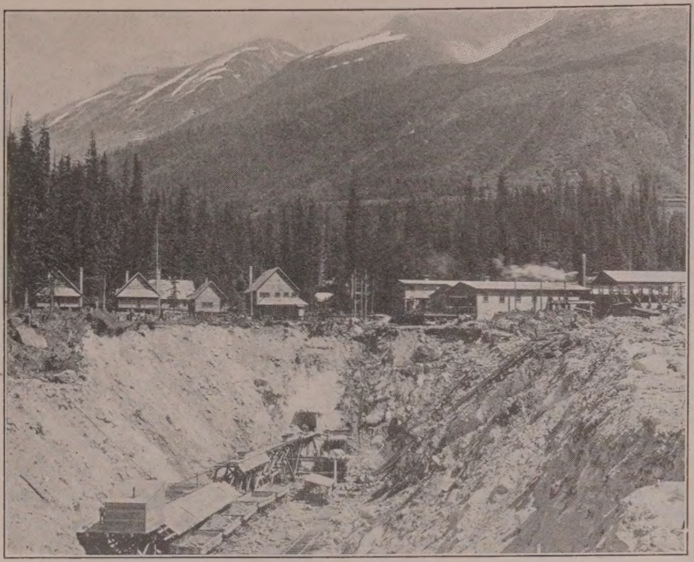
SOME newspapers saw in the results of the recent election evidence of a return from radical to more conservative views with reference to governmental control of private enterprise. Such a conclusion is likely to be tempered by political leanings. Nevertheless, there is evidence that the public at large believes that the pendulum formerly on the side favorable to industry has swung too far in the other direction. Saner views prevail and the swing back toward the mid-point has commenced. There are, nevertheless, many who believe that those who failed to be swept along by the current of the last five years were benighted and hopelessly subservient to private interests as against the public good. In a recent address before the National Implement and Vehicle Association, Harry A. Wheeler, vice-president of the Union Trust Company of Chicago, and former president of the Chamber of Commerce of the United States of America discussed the future of American business. In a masterly address he reviewed our economic history, admitting freely that corporations had until recently had the upper hand and were now suffering from the inevitable reaction. His estimate of present conditions is worthy of careful note. "Business is troubled to-day," he said, "because in the effort to overcome unhealthy conditions of the past we are confronted with the danger of cutting loose from some of our constitutional safeguards, and of making laws and establishing policies which are un-American and likely to be fraught with some danger to our industrial development. . . . Nature throws no guardianship around her subjects, but in the development of the species in the animal and vegetable kingdoms, survival is because of powers of resistance from within. In the moral law, the doctrine of free moral agency is unquestioned, and while the Almighty may punish an infraction of the moral law, He cannot compel mankind to observe that law. When neither in nature nor the moral kingdom the individual or the unit is made subservient, how can we justify political paternalism? . . . There is a real danger in this country, with our present tendency to place everything in the hands of regulating commissions, that we shall be led to experiment with paternalism at the expense of individual enterprise. Self government was not inaugurated to make the State great at the expense of the people, but to make the State only the instrument to protect the privileges and insure opportunity for freedom of action of the individual. Mediocrity, power loss and retrogression must ultimately be the heritage of any nation that so safeguards its people and controls their activities as to eliminate rewards for merit." These thoughts are worth pondering. There is grave danger that we shall make serious mistakes in government, and it behooves thinking men to realize the direction of the drift, to understand the danger and exercise their influence to force it into proper channels. Unquestionably there was great need for government intervention to stop the corporation excesses which attained their fulness in the last ten years of the last century. Possibly it was inevitable, too, that when the people came into their own they would go to the other extreme. Certainly the pendulum has swung too far and there is need to hold before ourselves steadfastly the principle of individual initiative which Mr. Wheeler has emphasized in order that we may as quickly as possible reach a normal condition, in which justice will be done to the corporations on the one hand and to the public on the other.

Near-Education with the Two-Year College Course

A WELL-KNOWN college president is quoted as having publicly declared himself as looking with some favor on a two-year college course, especially for those who are going into business, leaving two subsequent years of putative postgraduate study for rounding out the education of others. This will have a cheerful sound to those who desire an imitation of a liberal education. It suggests only too forcibly the specious argument put up by a certain bogus university, which shall be nameless here, and based on the liberal views of still another college president. The latter, according to the advance agent of the bogus university, feeling that the opportunities for the wider dissemination of college training should be improved, had with great breadth of view taken the stand that a college degree could properly be granted to a suitably prepared student on a single year of actual residence at the university, the rest of the required work having been done elsewhere. But, "our trustees," proclaimed the advance agent, "have followed the distinguished scholar's far-sighted proposition to its logical conclusion, and have arranged for the granting of a college degree without any actual residence at all, merely when the suitable course of instruction by correspondence, conducted through our admirable set of books, price —— dollars, has been completed."

There are two kinds of education, one of which is secured as the result of honest work, thorough, steady and well directed, the other obtained by hook or by crook in any way which does not involve too much time and trouble, or too strenuous attention to literary pursuits. The latter bears to the former about the same relation that a counterfeit half-dollar does to the genuine coin. It is not here in the least intended to suggest that the first of these college presidents stands for the counterfeit in education, but his program, if carried out, would lend itself altogether too readily to the exploitation of shams. It might be put through conscientiously and without disastrous results under his own wise direction, but at grave risk of setting an exceedingly bad example.

Two years of so-called postgraduate work on the top of the present freshman and sophomore years of any institution of learning would land the student exactly at the point he now reaches at the end of the four-years' course, and the so-called college course cut off two years earlier would be nothing better nor worse than it now is at the expiration of a similar period. What is needed in this country, and particularly in education leading up to technical pursuits, is not less time, but more, than is now available, time spent in thorough work with a definite aim in view. It is perfectly true that the average young man, whether going into business or a profession, is in the present state of things launched rather late into the serious business of life. This, however, is not in the main the fault of the colleges. The loss of time is in the shiftless and wit-scattering methods of the lower schools, particularly those which lead up to the so-called college preparatory stage. When the teachers in these humbler institutions realize that one thing well learned is worth a superficial smattering of half a dozen, and when the preparatory schools, backed up by those below them, get down to hard business, young men will be able to save a year in getting into college and consequently a very valuable year in getting out of college. This accomplished there will be small temptation for any university, big or little, to hand out educational apologies.



DRIFTS AT MAIN PORTAL—MOUNTAINS IN BACKGROUND

ENTRANCE TO INCLINED CROSSCUT IN PIONEER BORE

Piercing the Selkirk Mountains for a Five-Mile Tunnel

Double-Track Bore for Canadian Pacific Railway at Rogers Pass, British Columbia, Driven by Pioneer Heading Method

WHOEVER had pointed out the Rogers Pass tunnel site a few years ago, with an explanation of such a project as that now under way there, would have aroused skepticism in layman and engineer alike; yet the work is now well in hand, and although little has been said about it, the new method of construction being employed has thus far proved entirely successful. Unusual interest attaches to the work, not only because of the length and location of the tunnel, but also because of the rate of progress which the railroad company demanded, and the methods adopted by the contractors to shorten the construction period.

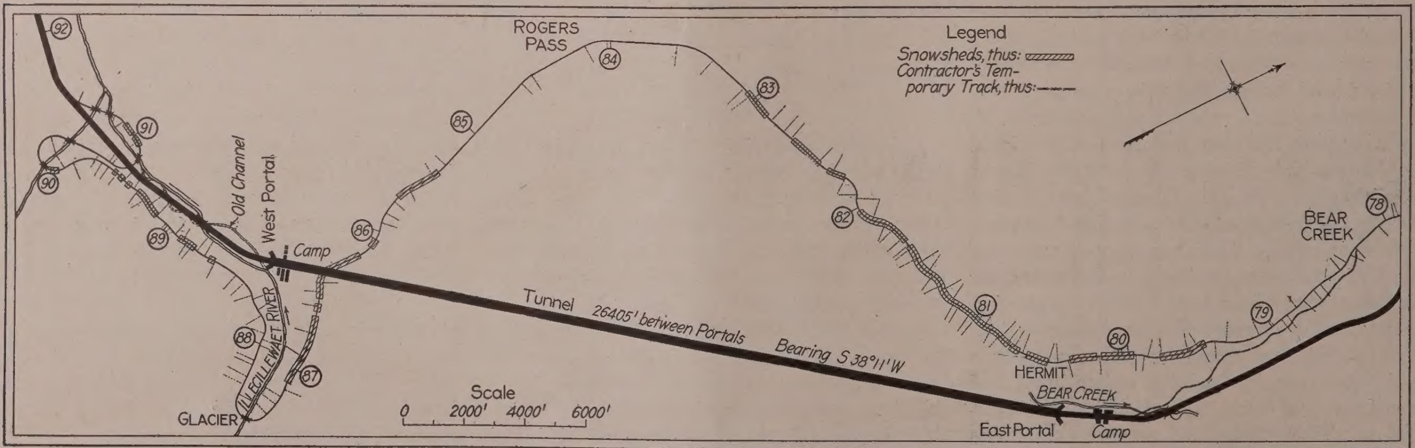
As the extremely high operating and maintenance cost on the track to be eliminated made it worth while, once the tunnel was decided upon, to spare no expense in rushing it to completion, a contract with a bonus and penalty clause was prepared, based on a 3½-year construction period. The contractors, in turn, met the extreme-haste requirements by planning to drive the tunnel from a number of headings simultaneously, using a pioneer or entirely separate tunnel for removing the muck and ventilating the inner headings. Thus several miles of 7 x 8-ft. pioneer tunnel in solid rock are being driven at the contractor's expense and for the sole purpose of expediting progress on the main bore.

From the west portal, which is about a mile from Glacier, B. C., the tunnel passes straight through Mt. Macdonald, El. 9860 ft., to a point 26,405 ft. distant on the bank of Bear Creek. The saving in elevation is 550 ft. and the route is shortened by 4.4 mi.; at the same time 4 mi. of snowsheds are eliminated, the annual maintenance of which is about $25,000 per mile. To connect up with the old route 1½ mi. of new track had to be located on the west and 11 mi. on the east, so that when the tunnel is opened for service 22 mi. of old main line will be abandoned.

Pioneer Heading Method

The pioneer bore is used for hauling out muck in trains of ½-yd. dump cars drawn by mules, and also accommodates ventilating and compressed-air pipes and telephone lines. Thus the steam shovel advancing from the main portal is not delayed by muck coming over the face, nor hindered in its movements by large or small pipes. Also, the drilling progresses in the center heading at the same time muck is being removed by the shovel, and the shovel works continuously, except that it is withdrawn for a few minutes while shots are fired and the fumes cleared out by a current of air forced toward the portal from the center heading.

The pioneer bores were begun at the earliest date possible and were being rushed even when the portal approach cuts were being started, so as to gain quickly the advantage of the multiple heading plan. At both portals it was found possible to save excavation by starting the pioneer bores on the right-hand side and above grade. Both are about 50 ft. off center line, the western pioneer portal being 135 ft. above grade and the eastern pioneer portal 53 ft. above grade. The latter runs in horizontally and reaches the main tunnel by crosscuts pitched down hill, while the western pioneer tunnel pitches down a 50-per cent grade for 389 ft. at its portal and thereafter continues on a level with the center heading. Muck will not be brought out through the pioneer tunnel portals after the full tunnel cross-section has advanced beyond the first crosscut, as the ½-yd. dump cars from the pioneer bore can then dump



MAP OF OLD AND NEW LINES AT ROGERS PASS, SHOWING SNOWSHEDS AND CURVATURE ELIMINATED BY THE TUNNEL most conveniently into the trains of 12-yd. cars used to serve the steam shovel.

CENTER HEADING

Once through the glacial drift and into the solid rock, the main tunnel will be advanced from each portal first as an 8 x 11-ft. center heading. This will be enlarged to full cross-section by crews working in from the main tunnel portals and assisted in handling the muck by air-operated steam shovels. From each portal the drilling crews will work well ahead of the shovel, supplied by air through the pioneer bore, and will thus not be interrupted by blasting or mucking. From the pioneer bore the crosscuts will be run into the line of the center heading and then from each crosscut this center heading will be driven upgrade. The crosscuts are being spaced at intervals calculated to allow for an equal amount of work in each heading.

Aside from the terms of the contract, another saving which the contractor may effect by rapid progress is the cost of a considerable length of pioneer bore in the central part of the tunnel. That is, if the pioneer bores advance rapidly enough, they will be deflected to follow along the center line of the main tunnel for a certain length near their intersection, without delaying the maximum progress in the center headings.

DRILLING METHODS AND PROGRESS

At the west end a two-fold purpose has been accomplished by locating the tunnel approach on a 900,000-yd. fill in the center of the valley for 1½ mi. from the portal; it puts the new roadbed up out of danger from snowslides, and provides a convenient dump for tunnel muck. Part of this fill near the tunnel will be made wide enough for a six-track yard.

From the fill the line passes through a 300,000-yd. cut and enters the portal at a level about 80 ft. below the original ground surface. Then for 400 ft. the material encountered is glacial drift, carrying hard quartzite boulders and a great deal of water. This material is so heavy that three thicknesses of 10 x 10-in. timbering was sometimes required in the drifts. Where the permanent timbers have been put in here, a seven-segment arch on a full half circle is used and double 12 x 16-in. timbers are put in with no space between. Beyond the glacial drift, rock is again encountered in which no timbering is required. In earth the excavation amounts to about 30 cu. yd. per linear foot, the dimensions of the cross-section being such that a concrete lining can be put inside the timbering, leaving a finished opening 23 x 29 ft. in section.

On the east end a somewhat similar location of portal approach has been adopted. The approach cut here was only 100,000 cu. yd., however, and although some 1200 ft. of glacial drift had to be traversed, the material in this was much safer to handle than at the other end, and a five-segment arch with single 12 x 16-in. timbers spaced chiefly on 18-in. centers was found sufficient.

ROCK ENCOUNTERED

In the inner portions of the tunnel the rock encountered so far has been schist, slate and quartzite, and from surface indications it is expected that no other material will be found. The quartzite is extremely hard and drilling progress in it is slow, although it is advantageously broken up by powder. The schist, which seems to predominate so far, is comparatively easy to drill, but is so tough that a second shooting is nearly always required.

The full section will be drilled up from the center heading by piston drills because of the greater economy of this type, but on the pioneer bore, where speed is the primary consideration, Ingersoll-Leyner drills using 1⅛-in. steel are to be used exclusively. Leyner drill sharpeners are used with oil furnaces, this fuel being found more economical for the purpose than coal. The shanks are tempered in oil and the bits in water. In the pioneer heading the drills are arranged three to the bar, and holes are sunk to a depth of 6 ft. The rounds each have from twenty-two to twenty-eight shots and three or four rounds are fired per three eight-hour shifts.

On Oct. 1 the pioneer bore on the west had been advanced 1689 ft. and was progressing at an average rate of 650 ft. per month when excessive water was not encountered. Some permanent timbering had been placed in the west portal and center and double-deck side drifts were in some 300 ft. On the east end the full tunnel section was completed and timbered for 450 ft., while the center heading was in 3100 ft., and the pioneer bore 5312 ft. The best drilling progress made thus far was in the month of July when the pioneer heading was advanced 720 ft. on the east end.

MECHANICAL EQUIPMENT

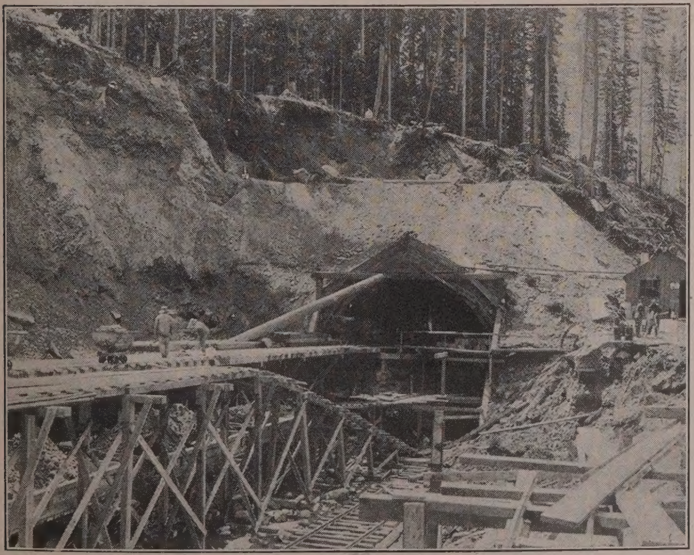
Practically the same power plant and equipment is installed at each portal; all machinery is driven by steam or compressed air, and to avoid electric wiring in the tunnel carbide gas lights are used. Each man is equipped with a carbide torch, for which he is responsible until it is returned in good order. The fuel cost is about 2 cents per shift per light. Where necessary the small hand torches are supplemented by ½-gal. gasoline flare torches. The only electrical equipment used by the contractors is for lighting camp buildings.

The main generating station at each portal has a capacity of 750 boiler-hp and is equipped with induced draft and special grates for burning slack coal, which is purchased at a low figure. Three compound condensing Ingersoll-Rand compressor units are provided in each plant. Two of these supply air at from 100 to 120 lb. per square inch, according to grade of rock encountered, and have a capacity of 1100 and 2200 cu. ft. of free air per minute respectively. The third is the high-pressure unit and supplies air at 1000 lb. per sq. in. for operating the compressed-air locomotives. Its capacity is 700 cu. ft. of free air per minute.

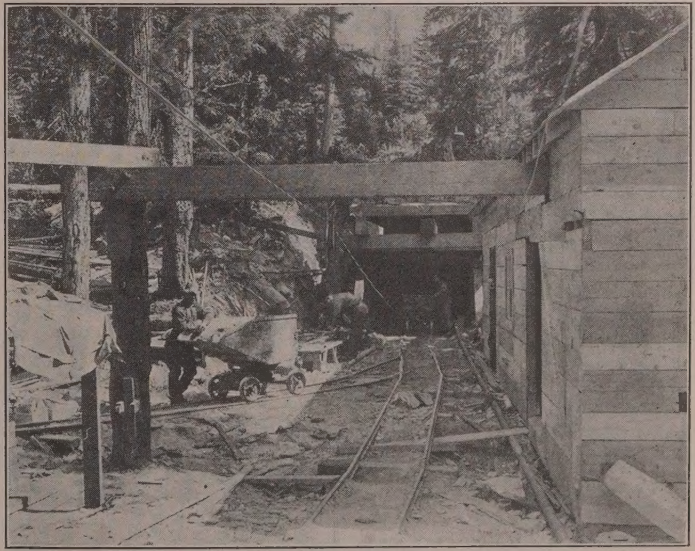
The movable equipment at each portal includes two 50-ton Davenport locomotives, two compressed-air locomotives, twenty 12-yd. Western dump cars, 100 ½-yd. Hudson side-dump cars, a Marion 41 steam shovel and a 35-ton locomotive crane, in addition to which there is a 100-ton Bucyrus steam shovel at the west end and an 85-ton Bucyrus at the east end.

The compressed-air locomotives have storage sufficient for hauling the maximum load 1 mi. They are for use in handling the 12-yd. cars in the main heading close to the steam shovel, and make only a short haul to a siding, whence a steam locomotive takes the trains on out to the dumping ground. A high-pressure compressed-air line is carried into the main heading and extended as the work advances to supply these locomotives.

Three Connersville blower units are provided at each end. One of these, a steam-driven fan with a capacity of 6000 cu. ft.



CLOSE VIEW OF EAST PORTAL AND HIGH LINE TRACK



OPERATIONS AT EAST PORTAL OF PIONEER TUNNEL per minute, is permanently located near the boiler plant, while two similar units, each of 4000 cu. ft. capacity, are set in the pioneer bore and arranged for compressed-air operation. The latter are intended to be moved ahead as the work advances; only one is required to maintain the air supply, but the two units are provided so that service need not be interrupted while the plant is being advanced.

These movable blowers have suction intakes near the pioneer headings, and discharge at the portal or through a crosscut into the completed tunnel. Powder gases that tend to linger at the heading are driven back to within reach of the ventilator intake by releasing compressed air at the end of the pipe line for a few minutes. One of the 4000-cu. ft. blowers is started when the first shot is fired and continues for about 20 min. The men return to work in about 15 min. The 6000-cu. ft. blower ventilates the center heading by forcing air into the pioneer bore. Brattices are provided in the pioneer portal and in all but the last crosscut, so that a current of air passes inward through the pioneer and out through the center heading.

At first galvanized-iron pipe was used for the ventilator units, but this has been replaced by 12-in. wood-stave pipe, which is said to be more satisfactory in every way. A few lengths of the discarded metal pipe are still used at the end of the line near the heading where damage from flying rock is likely. The pipes are laid on the ground to within about 200 ft. of the heading, after which they are suspended.

The work is being done for the Canadian Pacific Railway, of which J. G. Sullivan is chief engineer; F. F. Busteed, in charge of construction, British Columbia division, and J. W. Sheppard, assistant engineer in charge at the tunnel. The contract for the tunnel is held by Foley Brothers, Welch & Stewart, for whom A. C. Dennis is superintendent, and T. Truran master mechanic. J. Murphy is assistant superintendent in charge at the east portal, and J. Fowler is assistant superintendent at the west end.

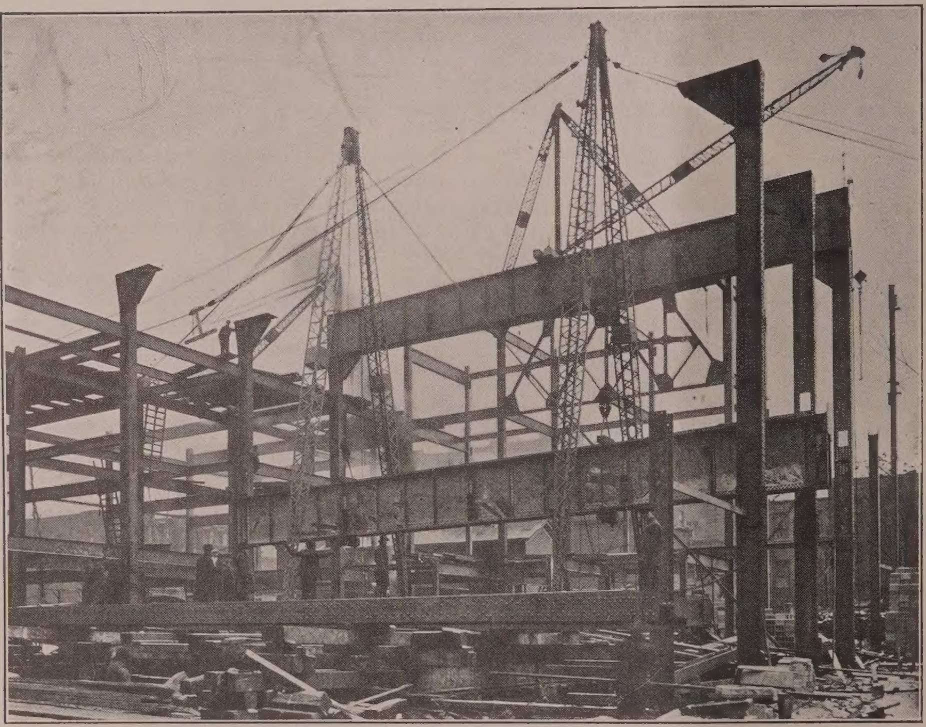
Erecting 36-Ton Girders with Steel Shears

Method Employed to Raise and Place Heavy Box Girders at Fifth Floor of Board of Commerce Building in Detroit

THE second-floor auditorium of the Board of Commerce Building, Detroit, is spanned by heavy box girders at the fifth-floor level, these girders carrying portions of the fifth, sixth and seventh floors and roof. They are 68 ft. 3 in. long and 6 ft. 2 in. wide back to back of flange angles, and weigh 36 tons each. They are seated on column brackets 44 ft. above street level.

They were erected by tackles suspended from a pair of steel shears about 60 ft. high that were quickly constructed at a very small expense from available material and members selected from the contractor's regular erection equipment. Each shear was made of two 60-ft. steel booms from regular 10-ton derricks mounted on a 10 x 12-in. stiffleg derrick sill and pin-connected to the regular jaw plates at one end of the sill, and to an extra pair of similar plates temporarily bolted to the opposite end of the sill. The upper ends of the booms were pin-connected to a pair of $\frac{3}{4}$-in. plates having a third pin for the four-sheave upper block of the hoisting tackle, which, like the lower block, was built up on two double blocks connected by new plates. The shears were mounted on 6-in. maple rollers under the sills, and were moved laterally by jacks. Each tackle was operated by a separate hoisting engine which lifted a girder in four or five minutes, after which about twenty minutes longer were required to land it.

The tackles were connected to the girders by pairs of yokes made of top and bottom wooden pieces and U-shaped vertical rods with screw ends. The shears were spaced 32 ft. apart longitudinally on the girders and each was guyed by two tackles which were operated to fleet the girder longitudinally after it was raised to the top of the columns. The method of erection was planned by J. L. Collier, vice-president and general manager of the Detroit Bridge & Steel Works, contractors for the fabrication and erection of the steelwork.



ERECTING WITH STEEL SHEARS HEAVY GIRDERS IN DETROIT BUILDING

Investigation of Sewer Air Following Boston Explosion

Methods and Results of Sampling and Testing Sewer Air and Experiments with Laboratory Samples of Gasoline Vapor

By H. W. CLARK

Chief Chemist, Massachusetts Board of Health, Boston

AT 10 a.m. on June 1 an explosion occurred in the sewer entering the pumping station of the Metropolitan sewerage system at East Boston. It wrecked the screen-house, a building about 30 ft. square, caused the death of six employees and badly injured two others. (See Engineering Record, Nov. 21, page 555.) The sewage leading to this station is largely from the north Metropolitan system, so-called, and this north Metropolitan sewer receives the sewage of seventeen cities and towns. Besides this, however, sewage comes to the station from the East Boston sewer of the Metropolitan system. This is a comparatively short sewer draining a portion of this section of Boston.

A day or two after this explosion I was requested by Dr. Henry P. Walcott, chairman of the Metropolitan Water and Sewerage Board to examine into the condition of the air in the sewers at this locality. It was known that the sewers here often smelled strongly of gasoline and it was supposed an explosion of gasoline vapor was the probable cause of this disaster. In the course of the investigation the odor of the sewer air was determined at many manholes throughout East Boston and also at the first manhole across the Chelsea Creek, this being upon the north Metropolitan sewer before mentioned.

SAMPLING SEWER AIR

Twenty-two samples of sewer air for laboratory determinations of explosiveness were also collected. In collecting the samples, both for laboratory tests and for the determination of odors, a small rubber tube was lowered through small ventholes in the manhole covers, the upper end of this tube being connected with a half-gallon bottle and the air drawn out of this bottle through a suction tube by means of an air exhaust pump. The pump was worked long enough at each collection to fill and empty the bottle at least three times. The air was collected from near the surface of the sewage in the sewers and often at a depth of from 17 to 20 ft. from the manhole cover. As a result of the many tests for odors made upon seven different days during June and July, it was found that gasoline vapor could always be detected in this way in the East Boston Metropolitan sewer in the vicinity of the pumping station and could at times be detected at manholes approximately $\frac{1}{2}$ mi. from the pumping station but not at other manholes at other parts of East Boston.

Twenty-two samples of sewer air, collected as described, were taken to the laboratory and sixty-five tests for explosiveness made with the explosion pipette. All samples collected from the manhole on the East Boston Metropolitan sewer opposite the pumping station were explosive with two exceptions, these samples being collected on June 10, 11, 12, 15 and July 10. The samples not explosive as collected were those of June 10 and June 15 as follows: The June 15 sample was supersaturated with gasoline vapor and would explode only when diluted with air and the sample of June 10 which did not explode when tested as usual but smelled strongly of gasoline was also supersaturated judging from this June 15 result. One explosive sample was obtained from a manhole about ¼ mi. from the pumping station and one from a manhole somewhat farther from the station than this.

Other samples collected in other parts of the city were non-explosive and practically odorless. None of the samples of air collected from the north Metropolitan sewer was explosive. Samples of sewage were taken from the sewers and examined for gasoline but not enough could be collected from these samples to explode.

GASOLINE CAUSED EXPLOSION

It was evident from this investigation that the cause of the explosion was the ignition of gasoline vapor, and it was also evident that this vapor came to the station through the East Boston sewer and not from the main north Metropolitan sewer coming across Chelsea Creek to this station. It should be said also that near this station are large storage tanks of the Standard Oil Company for the storage of oils, gasoline, etc., and that test pits dug in this vicinity show that the ground at some depth contains large amounts of oil.

The following laboratory experiments were made which are worth noting perhaps, especially as two of the samples from the sewer would explode only when mixed with air.

EXPERIMENTS WITH LABORATORY SAMPLES

To four half-gallon bottles gasoline was added as follows: To No. 1, 1 cu. cm.; to No. 2, 2 cu. cm.; to No. 3, 4 cu. cm. and to No. 4, 6 cu. cm. The bottles were stoppered, shaken vigorously and allowed to stand in the sun for an hour and the contents then tested, with the following results:

No. 1. Not explosive until mixed 1:1; that is, one volume of gas to one volume of air.
No. 2. Would not explode undiluted with air or when mixed 1:1, but was explosive when mixed 1:3.
No. 3. Was not explosive when mixed 1:1, but was explosive when mixed 1:3.
No. 4. Would not explode when mixed 1:1 or when mixed 1:3. Exploded when mixed 1:7.

To half-gallon bottles containing 1 in. of sewage, 1 cu. cm., 0.5 cu. cm., 0.25 cu. cm. and 0.15 cu. cm. respectively of gasoline were added, the bottles shaken vigorously and after allowing to stand some time, samples of gas were drawn off and tested.

TESTS OF EXPLOSIVE MIXTURES

The laboratory experiments showed that 1 cu. cm. of gasoline, vaporized in 4 liters of air, gave a strongly explosive mixture, this being about 1 part gasoline in 4000 parts of air; 2 cu. cm. in 4 liters and 0.5 cu. cm. in 4 liters of air exploded, but with less force. With the larger amount of gasoline the flash was distinctly luminous and carbon was deposited; 0.5 cu. cm. of gasoline in 4 liters of air is about 1 part in 8000 parts of air.

Amount of gasoline added (cubic centimeter)	Number of	
	Tests	Explosions
1.0	3*	3*
0.5	3	3
0.25	3	3
0.15	3	0

*Gas from the bottles containing 1 cu. cm. of gasoline would explode only when mixed with an equal volume of air.

Gasoline, according to Allen's "Organic Analysis," consists of hexane and isohexane, both having the composition of C_6H_{14}, but no reference to the amount necessary to give a perfect explosive mixture with air could be found. Groves & Thorpe's "Chemical Technology," Vol. 2, page 192, says:

"Petroleum spirit is not a liquid of uniform chemical composition and the specific gravity of its vapor varies roughly three or four times that of air. One volume of the liquid ordinarily gives about 141 volumes of vapor at common temperature and one volume of vapor will render about 113 volumes of air inflammable or about 35 volumes of air strongly explosive."

According to this statement, one volume of petroleum consisting of all the condensable products of petroleum distillation coming off before the kerosene, would, when vaporized, render over 15,000 volumes of air inflammable or about 5000 volumes highly explosive.

Our laboratory experiments seemed to show that one volume of gasoline would, when vaporized, render from 4000 to 8000 volumes of air highly explosive.

Dustless Concrete Floors

Capillary Attraction Is Utilized by a Special Process to Abstract the Surplus Water before Finishing the Surface

BY spreading dry cement and sand over burlap laid on the wearing surface coat of concrete immediately after it is struck off, sufficient moisture is removed to produce a dustless floor, according to P. M. Bruner, who controls the process. Up to the time of applying the burlap, standard specifications are followed. The dry mixture similar to that used for the wearing course is spread lightly on the burlap and distributed with a wood rake to a depth of ½ in. Capillary attraction abstracts the excess of water in from 20 to 30 min., as much as 25 or 30 per cent of the water from the underlying surface being taken up in this way. The mixture is then lifted by the burlap and dumped into the mixing box for the next batch. The surface of the floor is in perfect grade and ready for final finishing by wood float or trowel. At this period the whole body of the concrete topping is so stiff that no impression is made by walking over the surface or in working on the surface in the subsequent manipulations.

WHY CONCRETE FLOORS BECOME DUSTY

About three years ago Mr. Bruner concluded that the dusting of concrete floors was due to the fact that the setting of the cement is disturbed during the process of finishing. Owing to the excess of water necessary for the successful manipulation of the mortar used in the wearing course, considerable time usually elapses before the surface becomes stiff enough for troweling, since this surplus water must either evaporate or be taken up by the concrete base on which the top is placed. With a concrete sidewalk the wearing course is usually placed on an absorptive base which takes care of the excess water used in the mixing. In case the surface is applied directly to a reinforced-concrete floor which has previously hardened, there is no opportunity for disposition of this excess water. The same holds true when the top is placed on a rich, wet concrete similar to that used in reinforced work. The result is that in the interval which elapses while the excess water is disappearing the cement partly hardens and the late troweling has a tendency to break up the crystals formed. Further than this, any troweling has a tendency to bring up the excess water to the surface, forming a film of what is sometimes termed "drowned" cement. When wear takes place subsequently this surface film is the first to scale off, leaving a sandy finish which is subject to excessive abrasion, particularly on account of its own rough surface.

A number of floors of considerable area finished by this method have been in place for two or three years, and at present concrete floors in several buildings of the Chicago Telephone Company in and around Chicago are now being laid according to the above procedure by the P. M. Bruner Granitoid Company, of St. Louis.

MORE THAN 18,000 MILES of hard-surfaced roads were constructed in the United States during 1914, according to a statement by Logan Waller Page, director of the U. S. Office of Public Roads, in an address at the fourth American Road Congress, held in Atlanta, Ga., Nov. 9 to 14. This mileage, he said, is more than three-fourths of the length of the French National road system.

LAYING A CONCRETE FLOOR BY A NEW METHOD TO AVOID "DUSTING"

Results of Task Work in Cleaning Filter Sand at Philadelphia

The Output of the Force Was Increased 15 Per Cent in Spite of the Fact that City Ordinances Prohibited Bonuses for Excess Work

By assigning definite tasks the output of the force which cleans the filter sand at the water purification plants in Philadelphia, Pa., has been increased 15 per cent. The method of conducting the work under the new plan and the results accomplished thereby were discussed by Sanford E. Thompson, consulting engineer, of Boston, presented at the annual meeting of the American Society of Mechanical Engineers held in New York City this week.

The operation of the filters is under the direction of Carleton E. Davis, chief of the Bureau of Water. Morris L. Cooke, as director of Public Works, has general supervision over the work. An abstract of the paper follows:

The city of Philadelphia has five large filtration plants consisting of covered reservoirs operated by slow sand filtration. The water pumped into the reservoir from the Schuylkill and the Delaware Rivers, after passing through the pre-filters, percolates through about 4 ft. of sand and gravel and is thus purified. The impurities are caught largely in the upper few inches of sand, so that if this upper portion is washed the filtration area is practically renewed. Several methods of cleaning filter sands are in use, all of them involving considerable manual labor.

OBJECTS AND RESULTS

The object of the plan has been to lay out the work of each gang of men so as to increase the effectiveness of the plant and provide a definite task to be accomplished in a day. The results of the plan which is being put into operation are as follows:

Rotation of cleaning the filters is planned in advance by well defined rule. A definite area of sand to clean is assigned to each gang, this area depending upon the depth of cleaning necessary. This setting of tasks has increased the output of each gang 15 per cent and this should be further increased to at least 25 per cent. Accurate records are kept, showing the time consumed by each gang. Cost accounts, as well as pay-roll, are made up from the time tickets furnished to the men. Gang leaders are required to pay closer attention to their duties. Improved apparatus and machinery are under consideration. Methods of determining depths of sand to clean are being standardized.

OBSTACLES

The greatest obstacle encountered has been the city ordinance fixing the rate of pay of unskilled laborers on a level wage per day regardless of the quality of the workman or the amount of work he is able to accomplish. Another hindrance to efficient management that is found ordinarily in city laws is the fact that civil service regulation, while preventing the discharge of a man for political reasons, at the same time limits the power of discharge for inefficiency.

In the case under consideration, for example, the handling of the work would have been much simplified and made substantially automatic if it had been possible to provide, for a man well fitted to his work, a reward for accomplishing a good day's task. As this was impossible, and as it is unfair in any case to expect a man to do an exceptional day's work without an exceptional day's pay, the tasks laid out were lower than would be set under a proper system of task and bonus, and their maintenance was more difficult to enforce. At the beginning, the general attitude of the men and the foremen was antagonistic, as is almost always the case where new methods are being introduced. This is gradually overcome as the results become evident.

METHOD OF CLEANING

In the filtration plant first handled by the new method there are 65 filters, employing about 128 men for cleaning. Each filter is about 140 ft. wide by 250 ft. long, and is built with groined arch bottom and roof, having columns about 16 ft. on centers. The Nichols method of washing is used in this plant. In this method the dirty sand from the surface of the bed to a depth specified is shoveled to an ejector, furnishing water under about 85 to 100 lb. pressure, which forces it through a large hose into the separator, which is a cylindrical iron tank provided with a concentric baffle about 6 or 8 in. from the outside shell. The water and sand swirl around this, the clean sand settling in the conical bottom and passing out through a 2-in. hose below. The dirty water passes under the baffle and out of the top of the tank, whence it passes out of the bed through a hose and pipe to sewer.

From the separator the sand is returned by the hose to the bed, where it is properly distributed and leveled. Sometimes, according to conditions, the dirty sand is shoveled direct to the hopper of the ejector, and in other cases is scraped and piled. This scraping and piling is done usually as an independent operation by old men unfit for harder work.

Four washing gangs are required for each filter bed, the outside gangs having 2½ bays each and the inside gangs having 2 bays to clean. In each gang there are 3 shovelers to a hopper, two men shoveling at a time while one rests. Each man shovels 40 min. and then rests 20 min. The fourth man takes care of the hose from the separator, distributing the clean sand to the bed. A fifth man, recently introduced, working with 2 gangs, spades up the hard sand that has been uncovered before replacing the washed sand.

STUDYING THE PROBLEM

The method of attacking any problem in order to place it on a scientific basis varies with the character of the work. In certain cases, such as intricate factory operations, it is necessary, before any tasks are set or even before time studies are made, to establish a complete system of routing the materials and the employees. In other cases the first necessity is to establish standards, making minute investigation of the processes. In still other cases time studies can be made at the start.

In the sand cleaning proposition all of these methods were carried on in a measure simultaneously. Studies were made of the men and the methods employed to see where the manner of handling the work could be improved. Time studies were made to determine the unit times for each individual operation, so that the tasks could be figured accurately in advance. From records already on file, giving the approximate time for cleaning, it was possible to begin the organization of the routing system.

Besides the studies in this particular plant, time studies were also made on various operations in the other plants and methods in various places compared. The general laws of the variation of the filters as regards loss of head, rate, and turbidity, were sought by means of graphical tabulations and curves. Unit costs of labor in the past were investigated.

ROUTING

As soon as the preliminary studies were far enough advanced a bulletin board of the type used in the Taylor system was set up in the office at the plant, provided with suitable hooks for the tickets which designated the work of each man. One of the lines of hooks held tickets indicating "Work to be done, NOT READY"; a second line above it, "Work to be done READY"; and the third line, above this "WORK IN PROGRESS." On these tickets, which are 4¼ by 4¼ in., there is space for all the information required.

The order in which the filters were to be cleaned was designated by the superintendent. The time each task is begun is recorded on the ticket and also the time of completion. From these tickets records are kept at the plant in terms of labor-hours on every class of operation for each individual bed, and the payroll is made up from them. From the payroll division the tickets go to the cost division, where they are filed under the various charges, so that a monthly cost of operation sheet can be made.

A definite system of cross-checking is provided. Previously the time was charged against the various cost items by the gang leader on a daily report sheet and the payroll and the cost sheet made out from these were sent to the cost division. The results were inaccurate, as the charging of the time was kept by the gang leader.

The initial stages of the introduction of the new methods were under the personal direction of my associate, Mr. Lichtner. The system of routing was handled by Albert Tolson, and the studies and tabulations made by Lyle L. Jenne. As soon as the routine was established, it was taken over by Mr. Siddons, the superintendent.

Eventually, the central planning office will be established at City Hall, with auxiliary bulletin boards at the various plants and operated by telephone from the central office. This plan was started at the beginning, but it was found that further standardization of the method of determining the order in which the filters are to be cleaned was necessary before the centralized planning office would work satisfactorily. New record forms have been developed and the system is working smoothly.

UNIT TIMES

Time studies were made by the aid of the stop watch on the labor operations in the beds, such as shoveling dirty sand to hopper, cleaning up around hopper, moving hopper, moving separator, and moving track. These times for individual operations were then converted for direct use into the time per cubic yard for 1 in. of depth. Studies were also made on the rate of delivery of sand from separator and the effect of opening and closing the separator on the rate of shoveling. Different methods of handling the ejectors were also included in the investigation.

The object of the time studies was to find the time of each individual operation, so that unnecessary operations could be eliminated and the unit times of the necessary operations could be combined to apply to all conditions. Over-all time records are of no use whatever, because, for example, with each change in depth of shoveling, the number of moves of the hopper and of the separator vary.

The unit times for the individual operations were determined by the taking of a large number of time studies in such a way as to eliminate all unnecessary delays, but with a sufficient allowance for resting and delays which were unavoidable. The unit times obtained are given in the accompanying table.

Unit Times for Individual Operations

Operation	Unit time per operation, min.	Time per cu. yd. per 1-in. depth, min.
Moving hopper	0.20	0.34
Moving separator	0.50	0.45
Moving hopper hose	0.25	0.11
Moving track	0.83	0.44
Waiting for hopper to empty	0.42	0.38
Moving pressure hose	1.80	0.36
Additional necessary rest	....	0.12
Shoveling to hopper	....	6.32

The time given in each case is that for the gang, since it was necessary on this work to set a task for the entire gang instead of starting the individual men, as it is always best to do when possible. The time of shoveling into the hopper is in each case based on the rate of output that the ejectors will take care of. It was found that one man, instead of two, could very nearly produce the required output, but this would have lengthened the time of cleaning so as to be inadvisable. For example, with one man shoveling, the shoveling time per cubic yard is 8.8 min. with a 1-in. depth, and 6.75 min. per cubic yard when the depth is 18 in. These studies indicate therefore that further change is necessary in the method of operation so as to increase the output of the ejector and separator in order to obtain the full value of the labor of the gang.

Setting Tasks

Having determined the unit times and established the system of routing and giving out of tickets, the area of surface that should be shoveled by each gang was figured and the point to which they were supposed to go in a day's work was marked with a flag. In order to fix this, it is necessary to determine in advance by test holes the depth which should be cleaned, figuring the area from the volume at the required depth. Curves have been plotted, giving areas or rather distances to clean for the outside and inside gangs for various depths. These distances are converted into pier locations, so many feet in front or back of pier number so and so. The actual point reached each day is reported at the office and the mark for the following day calculated therefrom.

On the first two days, after everything was ready, no instructions were given the gang leader or the men as to how much they were expected to do. The total area shoveled by each gang, however, was noted, and compared with the area they should have accomplished. Every gang shoveled less than the figured area, the amount running from 10½ per cent less to 31½ per cent less. After this second day's work we concentrated on E-1 gang, since it is always necessary in order to avoid friction to work with a single man or a single gang, and laid out in advance the amount this gang should accomplish in a day by setting a flag at the point which marked the end of the day's work. As a result, they readily accomplished the task and reached the mark. The task setting was then extended to other gangs.

Accomplishments

The rates were set on the basis of a fair day's work which should be accomplished with a first-class foreman and with no incentive to the laborers. Because of this absence of incentive the work actually done averages considerably less than the actual tasks. To compare the amount of work accomplished before and after setting tasks the records were averaged of 27 cleanings taken at random from a period of 1½ years previous to the introduction of the new methods. These showed an average rate of 6.3 cu. yd. shoveled per day per gang. An average of 55 cleanings after task work was started gave 7.2 cu. yd. per day, an increase of nearly 15 per cent. This increase, however, was less than half of what it should have been, the figured rate being 8.4 cu. yd. per day.

Although the 15 per cent increase was well worth accomplishing, our tests showed positively that the larger increase of over 30 per cent should readily be accomplished with first-class supervision. One plan considered as a partial incentive is a record card for each man showing his output and thus indicating his relative rank as a workman. The rank of a man would influence the laying off if work is slack, or, on the other hand, if a man is required for a higher position, this ranking would be taken into account. If it had been possible to pay an actual money bonus, the task would have been set still higher and the output would have been increased about 50 per cent.

As the work on the filter management was getting under way, circumstances called the men in charge to other locations in the city temporarily. Going back to the job and making further studies, it was found that time had been lost by not throttling down the separator so as to make it run continuously and thus deliver its full output; by unnecessary throttling of the hopper and cleaning up ahead before moving hopper to next portion of pile; by not keeping spray open to fullest capacity. It was noticed whenever the gang was watched closely that they accomplished their task without any difficulty.

Apparatus

The studies, as is always the case where thorough investigations are made, indicated a number of changes advisable in the apparatus and methods of handling it. It was found that the lines of piping for the water used under pressure were poorly arranged, so as to require in certain cases long lengths of hose and a consequent deduction in pressure which largely increased labor costs. In other cases certain pipe lines had to be moved from bed to bed during the operation of cleaning. The studies have shown that a mechanical washing device probably can be devised which will greatly reduce the cost of cleaning.

Even with the present apparatus the method of handling the separators and ejectors can be considerably improved and the cost of this quickly made up by labor saved. The design of the hoppers and separators, as already stated, could be improved so that they would handle just the right amount of material that a gang can readily shovel. The present output is limited by the design of the hopper and ejector. These various matters are under consideration and improvements are being made from time to time.

Conclusions

It is evident from the results obtained here and also from similar experience in other work that output on city work can be appreciably increased simply by careful planning of the work in advance, systematizing its handling, and following it up in routine fashion. To obtain the full value of organization, however, it is necessary to provide some definite incentive to the men to accomplish their tasks. This makes the handling of the work automatic and eliminates friction, and, especially, gives the men the extra money which they actually deserve whenever the tasks are set high enough to require a good day's work.

Solving the Silt Problem

Reservoirs Suggested for Muddy Streams of the Southwest—No Danger of Such Reservoirs Silting Up to a Material Extent

By LOUIS C. HILL
Consulting Engineer, United States Reclamation Service

THE Colorado River and other streams of the Southwest carry silt in such quantities that unless proper provision is made irrigation canals fill up, headworks become choked and even in the natural channels continual deposition raises the stream bed to such an extent that high water endangers property in the lower reaches of the valleys. Since extensive irrigation has been undertaken the problem of what to do with the silt has been carefully studied and various schemes have been proposed for handling it or separating it from the water at the heads of the canal systems.

The experience which has been gained by irrigation engineers in the Southwest, however, shows that proper diversion dams with properly designed devices for excluding silt from the canals will reduce trouble from this source to a minimum. The finer silt that enters the canals in spite of these precautions usually remains in suspension long enough to reach the land and add greatly to its fertility.

A number of causes could materially reduce the quantity of silt carried by the Colorado below the canyon, chief among which are control of flood waters, resulting in more uniform flow in the lower river; more extended use of water for irrigation, both on the tributaries and on the main stream, and a regulated, permanent channel.

Silt in the Reservoirs

Much has been said about the danger of silting up large reservoirs, thereby lessening the storage on which the water supply of a region depends. This criticism is not well founded if a life of from three hundred to a thousand years is considered as fairly justifying the construction of the works.

On the Rio Grande about 120 mi. north of El Paso, Texas, tests showed that 1⅛ per cent by weight of the river volume was silt in suspension. When deposited and compacted this weighed from 75 to 80 lb. per cubic foot. The Elephant Butte storage dam on this river will have a capacity of 2,600,000 acre-feet, part of which is to serve as silt storage for the next fifty or sixty years. The dam is to be first built 318 ft. high from foundation to parapet wall, but the gates and other structures are designed so as to permit increasing the height by 40 or 50 ft., thus increasing the capacity by 3,000,000 acre-feet, which additional capacity would provide storage for all the silt brought down in 250 or 300 years. Later more expensive reservoir sites could be developed or the dam raised still higher, extending the life of the project indefinitely.

COST OF PROVIDING STORAGE

The foundations would have to be made wider, of course, and the thickness of the dam increased when the crest was raised, but this work would all be done on the downstream side and would not interfere with the function of the dam. The cost of providing silt storage on this basis would not exceed about 4/100 cent (four-tenths of a mill) per cubic yard. It should be noted, however, that it would not pay to make at the present time the expenditure required by this increase of capacity. The interest on the investment even on the foundation work alone would far exceed the capital invested in 50 or 60 years.

On the Salt River the proportion of silt in suspension was found to be only about ¼ per cent of the total flow. On this river the Roosevelt dam was recently raised 5 ft. at a cost of about $4,000. The additional storage capacity of nearly 100,000 acre-feet thus provided is expected to store the silt brought down by the stream for a period of 50 years. Dividing the cost of this work by the storage it is seen that the silt is provided for at a cost of 2½ cents per thousand cubic yards.

There is no engineering difficulty in the way of raising Roosevelt dam 100 ft. higher and thereby caring for the silt for a thousand years at a cost relatively insignificant. This construction work need proceed but slowly, enough work being done each time to provide storage for the silt deposited in from 60 to 100 years. This would distribute the expenditures over the entire time and put the burden on the beneficiaries.

Complaints to Illinois Public Service Commission

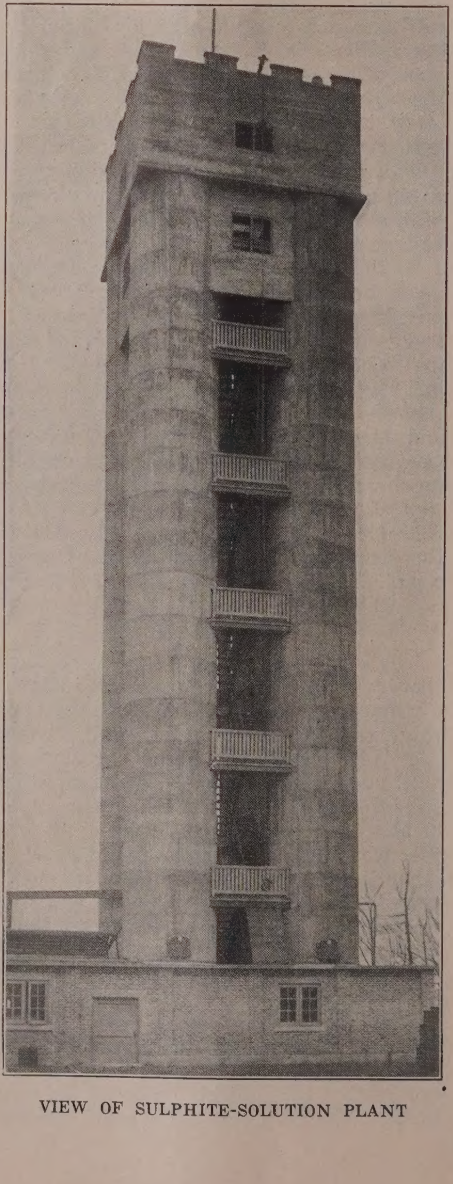
OF complaints to the Illinois Public Service Commission, 60 per cent are informal and are settled by co-ordinating differences between the consumer and the utility, according to a paper presented to the Western Society of Engineers Oct. 19 by R. M. Feustel, chief engineer of the commission. In his opinion an ideal would be to have 90 per cent of the complaints so handled. The real business of the commission, he stated, is to promote a better understanding between the utility and the consumer. While Mr. Feustel's men are attending to complaints they also conduct service tests. For this purpose the State is divided into four divisions with headquarters in Chicago, Springfield, Peoria and East St. Louis. In Illinois only in cases where a rate case is brought before the commission is a valuation taken, and the utility is then ordered to make one which the commission's engineers check. This checking costs but 10 or 15 per cent of the amount an original valuation would cost.

Sulphite-Solution Plant of Reinforced Concrete

Four 99-Foot Towers 8.5 Feet in Diameter with a Special Tile Lining Contain the Limestone

A PLANT for the manufacture of sulphite solution has recently been completed for the Hammermill Paper Company at Erie, Pa. It consists of four towers 99 ft. high, resting on one foundation 32 ft. square and 6 ft. thick. The purpose of the towers is to retain lime rock, and they are charged from the top, rock being placed by an elevator and stored in the housing on top of the towers. In the process used water is sprayed in at the tops of the towers and acid employed in the manufacture of paper is drawn off at the bottom.

The heavy foundation is reinforced parallel and diagonally to the sides. The vertical members of each tower extend down into the foundation and are anchored beneath the horizontal steel of the foundation. The towers have a uniform inside diameter of 8½ ft. All vertical reinforcement consists of ½-in. square twisted vertical bars; for the first 15 ft. there are twenty bars, for the next 30 ft., eighteen bars; for the next 30 ft., eighteen bars, and for the remaining height of 30 ft., twelve bars. The rings which encircle the vertical members consist of ⅝-in. round bars 5 in. on centers in the lower 14 ft. of the tower, the centering of these bars decreasing to 20 in. on centers in the upper 25 ft.



VIEW OF SULPHITE-SOLUTION PLANT

The tower is lined with special tile made for the exact radius of the inside of the tower. The tile is laid up in an acid-proof mortar.

HOUSING

The housing at the top of the towers is 25 ft. 4 in. square and 7 ft. 6 in. high. Its floor is a reinforced-concrete slab extending over all four towers and heavily reinforced to carry the loading imposed upon it by the rock stored in the housing. On top of the housing is a water tank 11 ft. square and 3 ft. high, and an elevator housing 7 ft. high and 6 ft. 6 in. square. The roof of the housing is supported by light walls and four columns. In addition to the elevator, which is used for hoisting rock, there are stairs to the tops of the towers, with landings spaced 15 ft. apart. The landings rest on I-beams, which were placed in the towers at the time of construction and carry, in addition to the landing and stairs, the necessary piping, etc. Below the housing are curtain walls which protect the necessary machinery at the top from the weather. Above the grate in the bottom of the tower is a cleanout door, visible in the accompanying photograph, permitting the towers to be cleaned at any time desired.

The system was devised by G. D. Jenssen, sulphite expert, of Boston, collaborating with the chief engineer of the Hammermill Paper Company, under Percy Klund. The work, including foundation, towers, housing, etc., was contracted for and executed by the Weber Chimney Company, of Chicago.

No Demurrage for Delays in Panama Canal

ON account of the delay of one of its vessels due to the new Culebra slide a steamship company inquired if claims for demurrage would be considered by the Government. The Governor of the Canal Zone replied that the Panama Canal is not to be held responsible for such delay and added, "It may be of interest to state that the original date for the completion of the canal was Jan. 1, 1915, but that the construction work was so far advanced, though not entirely completed, in August of the current year, that it was decided to offer vessels the privilege of using it before the official opening. When this slide occurred it was considered advisable, as a matter of precaution, to give the dredges and other equipment the right of way for a few days, to engage in construction work, in preference to the vessels that were waiting transit through the canal."

FISH PONDS OF SEWAGE are provided for Bergedorf, Germany, a suburb of Hamburg, inasmuch as the town is removed from any large stream and the effluent from the Imhoff tanks and sprinkling filters is not considered complete enough to turn into the small watercourses. Dr. Edward Bartow, in a recent paper presented before the Illinois Section of the American Waterworks Association, stated that satisfactory results were obtained without dilution. Purification is effected by water plants that make the ponds suitable for fish culture. Carp less than 6 in. long grow to a length of 18 in. in a single summer. The flesh is good if the fish are transferred to pure water for a few weeks before they are eaten.

Educational Field for Highway Departments

Abstract of Paper Read at Fourth American Road Congress by Dr. Joseph Hyde Pratt, State Geologist of North Carolina

EDUCATIONAL work carried on by State highway departments should reach the departmental employees, the county and township road officials and the people of the State. Starting with this proposition, Dr. Joseph Hyde Pratt, State Geologist and Engineer of North Carolina, in an address at the Fourth American Road Congress, discussed the steps that should be taken to gain the desired end. His remarks are abstracted in the following:

At least once a year, declared Dr. Pratt, all engineers and superintendents in the State employ should be brought together, with expenses paid, for a conference. Instructions should be given by the head of the department, and it would be well to have prominent engineers address the men. Such conferences would be of special value in developing the younger members of the organization.

CO-OPERATION

Co-operation must be the keynote of education of the local road officials. The State department must first be able to show that it has something to give to the county better than the county has. The county and road commissioners must be brought to realize that it is just as necessary that they have a competent engineer in charge of their county road work as it is for the State in State work; and if the State roads have been built in a creditable manner, there is not much difficulty in demonstrating this point. It is harder, however, to convince them that it is necessary to have men trained in road construction to act as superintendents of their roads. It is in the appointment of superintendents and foreman that politics has played too great a part in road work. These men should be absolutely under the control of the highway engineer, and should be familiar with and trained in road work.

Road institutes should be held in the counties and location, construction and maintenance should be taken up and discussed. The county superintendent of roads, or the county road engineer, if there is one, should hold these meetings once a month or once in two months, when he will go over with his foreman and supervisors different phases of the road work and give them an opportunity to bring up any questions or problems that have come up during the previous month in regard to their work. The State highway department should have general supervision of these foremen's institutes.

INSTRUCTION IN MAINTENANCE

One feature that is constantly needing development, and regarding which supervisors and foremen need constant instruction, is maintenance; and at the institutes instruction can be given as to how to repair temporary serious breaks on bridges, culverts or the surface of the road, so that the road is made passable until the superintendent can be notified and a force of road men detailed to make the permanent repairs.

The information which it is desired to convey to the road engineers, superintendents and foremen is better supplied by short pamphlets on the different subjects than by one book. The highway division of which I am director has published a series of good roads circulars on the following subjects: "Dirt Roads and Their Maintenance"; "Suggestions to Road Officials Concerning the Construction and Drainage of Public Roads"; "Construction of the Sand-Clay Road"; "Status and Duties of the Road Engineer"; "Economics of Convict Labor in Road Construction"; "Organization of Road Forces"; "The Use of the Abney Hand Level"; "Construction of the Split Log Drag"; "Culverts and Small Bridges for County Roads".

A State highway department can only live and develop as it is able to show to the people that it is efficient and of economic value to the State. Where we have three sets of road officials—State, county and township—in charge of different portions of a State's system of roads, there is more or less conflict between the county and township officials and the State officials, and this is apt to engender a feeling of antagonism against the State department. This will always be the case until our people, as a whole, realize that the welfare of the State must come before that of the county; the county before that of the township; the township before that of the community, and the community before that of the individual family.

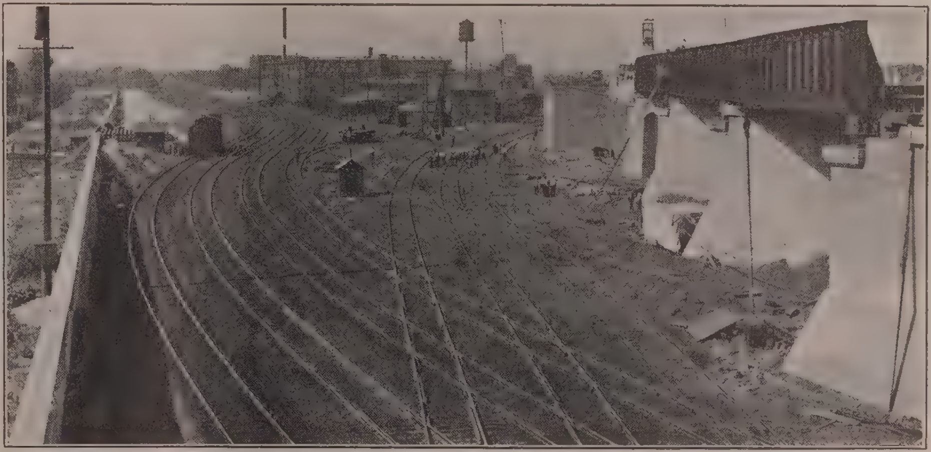
REACHING THE PUBLIC

Effective publicity may be secured by giving lectures at the county seats and especially by issuing illustrated reports containing comparative costs. In many States counties and townships have been authorized by the legislature to issue bonds for road construction. In some States the department has the supervision of the location of the roads built after the bond issue. In other States the whole control of the expenditure of the bond issues is left to the local authorities. In this case the State department could only act in an advisory capacity. It should, however, try in every way to give assistance to the local road officials, not only in the location of the road, but also in its method of construction. This will be accomplished largely by educational methods and can be brought about by consultation of engineers of the State highway department with the local road officials. In giving advice regarding the location they should explain in detail their reasons for the location made, and show how, in the end, it makes a cheaper and better road. They should assist in the determination of suitable surfacing material and advise the local officials as to the most suitable and economical material available.

One other phase of educational work is that of constructing a sample or model road in those sections of the State where there are no good roads and the people are not aroused to the need of them. The construction of a quarter or half a mile, or even one or two hundred yards, of good road will often be the means of arousing the community to a realization of what it needs.

Operation at Rock Island-Western Indiana Crossing, Chicago

MAINTENANCE of traffic operations at the crossing of the Chicago, Rock Island & Pacific Railway and Chicago & Western Indiana Railroad at the same time the tracks of both roads were being elevated and the grades separated, formed one of the problems encountered by the track-elevation engineers. Accompanying is a view looking north from Seventy-ninth Street along Wallace Street. The new Rock Island bridge over the Western Indiana is seen on the right, while at the foot and to the left of the new structure are the old Rock Island tracks, which will be taken up when the new elevated tracks are thrown open for service. The elevation of the Western Indiana tracks can be seen in the left background of the picture. The double curve in the Western Indiana tracks was of a temporary nature. Some time ago this curve was taken out and in one day the tracks were thrown back to a tangent passing through the bays of the new Rock Island bridge. A description of the Rock Island track elevation work may be found in the issues of Aug. 1, page 122, and Aug. 15, page 190.



MAINTAINING TRAFFIC WHILE SEPARATING GRADES AT BUSY RAILROAD CROSSING

HEADS OF DEPARTMENTS in the municipal service at Dayton, Ohio, where the city-manager plan of government is in effect, are selected with regard to their qualifications for the particular functions which they direct. The director of law was on the charter commission as its legal representative. The director of finance was a public accountant. The director of welfare was a minister—broad, intelligent, doing his greatest work outside of his church. The director of service is an engineer trained in municipal work and brought to Dayton for this service. The director of safety has not been appointed; the city-manager, Henry M. Waite, is acting director.

Construction Methods and Plant for Diversion and Drainage Works

Forty-three Million Yards of Ditch and Levee Work for Little River Drainage District in Missouri Included in 29 Contracts Involving $4,000,000

THE reclamation of the 900-sq. mi. Little River Drainage District in southeastern Missouri involves the construction of levees and large flood channels for the diversion of headwaters, digging about 624 mi. of local drainage ditches, and the construction of three lines of main drainage channels and levees, all of which will be done by excavating machinery of standard type so arranged as to have long continuous service. The smaller ditches, although of ordinary character, are of interest on account of the large amount of material, 34,208,101 cu. yd. to be excavated, and the measures taken to reduce the cost to contractors. The work on the flood channels and levees of the storage basins and outlets involves special methods of excavating large-dimension channels and handling soft material, and the installation of large machinery. It is facilitated by special diagrams giving by inspection quantities and dimensions required by changes of channel sections that may be made in the field.

The drainage ditches are from 4 to 123 ft. wide at the bottom, from 8 to 11 ft. in average depth, and have side slopes of about 1 to 1. They are from 0.32 to 98 mi. long, usually located about 1 mi. apart and run north and south through a flat country having a slope of about 1 ft. per mile. Most of them are dug through alluvial soil in swampy or submerged land, which has first to be cleared of a thick second growth of timber.

CLASSIFICATION OF WORK

Great care was taken by the engineer to classify the work and divide it into contracts so arranged and of such magnitude that each one would be suited to a certain type of excavating machinery and would be of sufficient size to be attractive to the contractor. They were also given enough time, usually at least 30 months, so that the work would be most economically handled by a number of units, often duplicates, working continuously without extra cost for stopping or transferring the machines. This work is adapted to 1-yd. and 1½-yd. floating dipper dredges, which under ordinary conditions have an average capacity of about 20,000 to 35,000 yd. per month with a crew of five men per shift, exclusive of the force necessary for clearing the ground in advance.

Generally the dredges are knocked down and are transported to a railroad spur at the head of the drainage ditch where they are assembled and commence operation in order that they may work continuously downstream, thus impounding above them sufficient water to float themselves and avoiding the necessity of building successive dams in the rear to retain the water that would be necessary if operations were commenced at the downstream end.

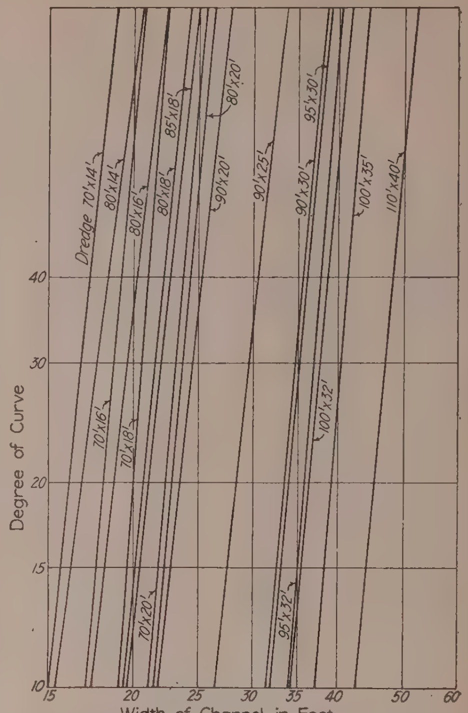
The work so far done has solved the question whether it was possible for a dipper dredge to take a side slope satisfactorily. While it is admitted that when the berm is submerged it is not easy to make the slope as smooth and exact as in firm dry soil, it has been demonstrated that in ditches with bottoms as narrow as 4 ft. the sides can be excavated to a slope of 1:1 by a dipper dredge if sufficient care is exercised by the dredge runners. In the prevailing soil this slope has been found to be a permanent one, not subject to material sloughing or caving in and has required little or no maintenance after construction.

DEEP CHANNELS AND HIGH LEVEES

The contracts for the diversion work are separated from those for the drainage work so as to facilitate their earlier completion. This divides the work into nearly equal portions. Machines of a different type and larger capacity are required for the flood channels and levees than for the drainage ditches.

The flood channels, from 74 to 112 ft. wide at the bottom have a maximum depth of 17 ft., with side slopes of 2:1 and ¾:1 and an aggregate length of about 34 mi. Spoil is deposited in banks with 3:1 slopes and a 40-ft. berm on one side of the flood channel, while a secondary channel large enough to provide a spoil bank 15 ft. high and 8 ft. wide on top is excavated parallel to it on the other side of the wide flood-way. In the river improvement the spoil is deposited on both sides in continuous waste banks with berms 20 ft. wide between the toe and the banks.

The entire work will be done with excavating units having a capacity of 2½ to 4 yd., including dipper dredges, hydraulic dredges, drag-line scrapers, and a combination plant having a 5-yd. clamshell bucket operated by a 125-ft. boom necessary to handle the material from the largest prism. This is required, although the limits of the spoil bank are within the range of a 100-ft. boom, and would suffice if the spoil stood up, but it is feared that it may creep and will, therefore, have to be leveled down and thrown back.

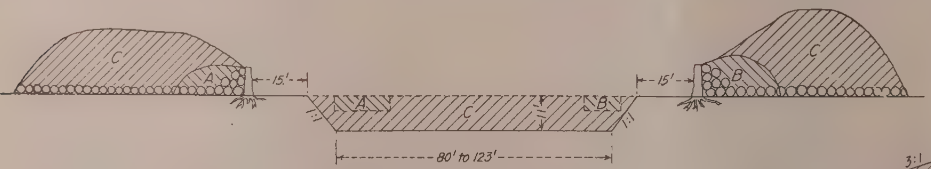


DIMENSIONS FOR CURVED ALIGNMENT

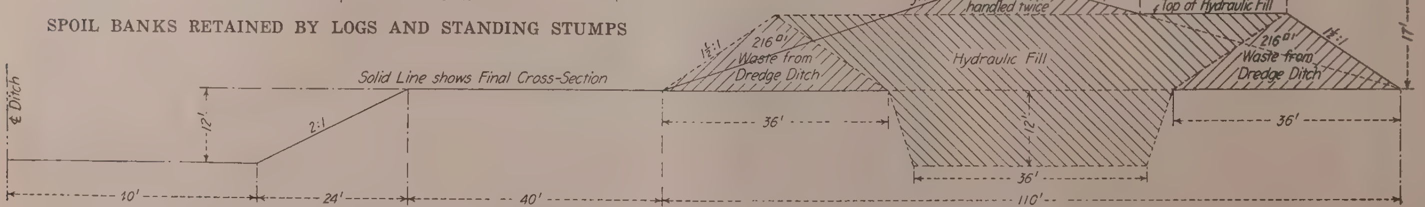
Alternative plans have been proposed for the construction of the high diversion levees built on the banks of channels excavated by hydraulic dredges. One of them contemplates the preliminary excavation, on the center line of the levee, of a trench 12 ft. deep and 36 ft. wide. This would be done by a dipper dredge depositing the spoil in banks about 12 ft. high with 1:1½ slopes on both sides of the channel. This channel would then be filled up to the tops of the spoil banks by the hydraulic dredge and the balance of the excavation, amounting to about 8 per cent of the whole cross-section of the main channel prism, would be deposited on top of the bank by a drag-line machine.

UTILIZATION OF TIMBER

As most of the land where the drainage channels and levees are located is covered with cypress timber, an alternative plan has been proposed which would utilize it in the construction of the channels and would avoid rehandling any of the spoil. Berms 15 ft. wide would be left on each side of the channel and the trees for 40 ft. from the bank line would be cut off at a height of about 6 ft. above the surface of the ground. The fallen timber would be piled longitudinally against the stumps, forming a timber banquette. A 1½ or 2-yd. dredge would precede the main plant, making a pilot cut on each side of the channel and



SPOIL BANKS RETAINED BY LOGS AND STANDING STUMPS



METHOD OF BUILDING SPOIL BANKS OF HYDRAULIC FILL RETAINED BY TRENCH AND LEVEES delivering its spoil as a surcharge for the banquette. This work would be done in advance of the main excavation to permit the spoil to season and form an impermeable levee to retain the remainder of the spoil discharged by the dipper dredge. Sufficient right of way is provided to permit the spoil to be jetted down to an average depth of 5 ft.

PLANT TO BE USED

The 4½-yd. main dredge will probably be located on the center line of the channel, anchored with the stern spud as a fulcrum about which it will swing to the bank on either side, thus securing an increment of at least 5 ft. to the reach of its 100-ft. boom. It will advance about 50 ft. at each move and is estimated to have a capacity of about 100,000 cu. yd. per month.

Part of the headwater diversion work will be executed by a 4-yd. Lidgerwood-Crawford drag-line scraper bucket outfit, weighing about 150 tons and moving on four-wheel standard-gage trucks. As much of the location is in wet or submerged ground this machine will be proceeded by a pilot dredge excavating a drainage channel.

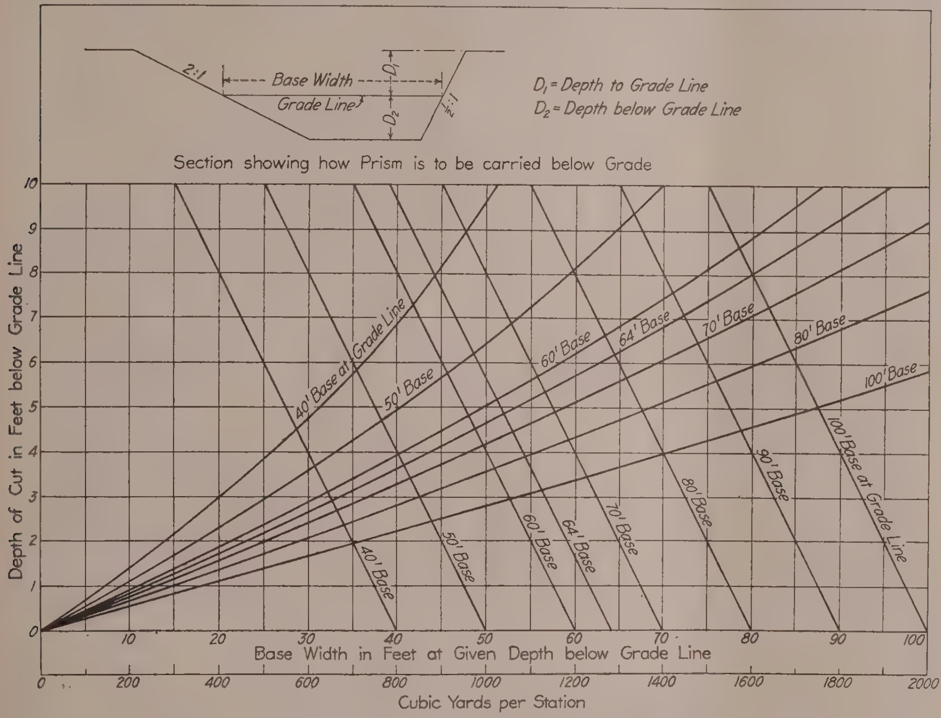


DIAGRAM OF QUANTITIES PER 100 FEET EXCAVATED BELOW GRADE

The outlet of the flood channel to the Mississippi River will intersect the present Government levees, which must be cut to receive it, but will not be removed until the entire work west of it is completed, thus making it necessary to carry the construction units over this embankment by shoring and to install a small centrifugal pumping plant to carry the storage back.

FIELD DIAGRAMS AND DRAINAGE RECORDS

Diagrams have been provided to facilitate the work of the field engineers, which give the width of channel required on the bottom to allow dredge hulls of different dimensions to pass around curves of different degrees. Another very convenient diagram has been prepared to show to what depth below the required grade-line of the channel it will be necessary to excavate in order to secure any given extra amount of spoil needed to fill out the levee. The contractors are permitted to increase the section of the channel if necessary in order to secure more convenient and economical borrow-pits by continuing the work to a greater depth, maintaining the specified side slope, however, rather than by installing a machine at some other point or hauling the material. This diagram enables the yardage corresponding to a given depth, or the depth corresponding to a given yardage to be found by inspection.

The drainage work is divided into four residences, each in charge of an engineer to whom there is assigned one rodman and one chainman, their instruments and additional help necessary being furnished by the contractor. The engineer is required to keep an engineering record, notebooks, diary, loose-leaf binder estimate sheets, construction reports, weekly reports of contractor's work, order books, weekly reports of engineering work, monthly estimate sheets, pay-roll and expense accounts, and table of excavations for various base width. Inspectors make daily reports to the resident engineer and the latter makes weekly reports to the chief engineer.

FIELD ENGINEERING

At the commencement of the work the resident engineer stakes out the true centerline on each contract to sufficient distances in advance of the dredges to permit uninterrupted prosecution of the work. All openings for drainage and the intersections of all lateral ditches are staked out, and where the natural surface is uniform, with no natural drainage points, openings are left alternatively every 500 ft. Where natural water-courses or sloughs are intersected, the downstream side is dammed by wasting excavated material there up to the general elevation of the land surface. All natural ditches are connected to the receiving ditch by a curve, the radius being that required for the passage of any given-size dredge. This radius is given by the standard diagram previously mentioned. Bench marks are re-established at a sufficient distance from the ditch center line to remain undisturbed by the clearing. All section corners found, including those noted by the locating parties, are reinforced by trees standing clear of any possible mutilation by right-of-way clearing.

When each contractor commences work he is advised in writing of the general conditions required of him by the resident engineer. If, after a month, the contractor does not comply with the plans, specifications and conditions outlined, he is notified in writing that if his work included within the next month's estimate does not conform it will be discontinued. If the defects are of a minor nature, consisting largely of cleaning up, the work is approved for payment, subject to immediate compliance with instructions relative to correction. When the defects are of a serious nature the work is not approved and no new work is permitted until the defects have been corrected. If evidences of sand are found in prisms more than 5 ft. deep when the clearing is staked out, they must be immediately reported to the chief engineer so that he may determine whether or not alterations shall be made to prevent sloughing of the banks.

DRAINAGE CONSTRUCTION REQUIREMENTS

Where ditches have wide prism widths they must be constructed with very great care that the waste material does not pile up and creep. To secure a stable toe for large masses, a pilot cut is required from which the material must be wasted along the berm-line and permitted to season before completing the prism. The berm must be of full width and practically clear. Excessive roll may be cleaned off by placing the dipper on the back side of the roll, holding it about 4 in. above the natural surface, and pulling the roll into the ditch with the backing line.

Great care is taken to make the levees impermeable and it is required that all vegetation, except in some places above the ground, shall be removed, and that lumps of earth, layers of gravel and the like must not be allowed to collect at the bottom. All unreliable material must be removed from the levee area, the ground thoroughly ploughed or broken, and the embankment material selected to give a tight, compact mass. All levee embankments must be built on lines 10 per cent in excess of the theoretical section to provide for shrinkage and wasted material must be piled back of the levee. All well-defined channels are crossed with steel sheet piling which must be driven to a general penetration of 8 ft.

DIVERSION WORK

On the headwater diversion work there are two residences, each of them having an engineer with one rodman, one chainman and a sufficient force of inspectors. The books kept are the same as those for the drainage ditches, except that the order books and tables of excavation are omitted.

Material for forming levee embankments is obtained from the diversion channel and when the prism is insufficient for this purpose additional material is obtained by carrying the channel prisms to a greater depth, in accordance with the chart corresponding to any given borrow in cubic yards. Care is taken that the first cutting of the channel prism, containing roots and grasses, is thrown clear of the levee. In order to be sure that all seepage from sand strata opened by channel excavation is cut off by the next ditch, borings are made with a

1½-in. auger along the levee base and in the bottom of the next ditch after the latter is excavated to required depth.

The work described is divided into twenty-nine contracts varying from about 146,000 to 4,600,000 yd. each, few of them being less than 500,000 yd. The contracts are awarded to fourteen different firms and, including the clearing of 15,222 acres, aggregate $3,965,949.83. The work is being executed under the direction of the Board of Supervisors, of which William A. O'Brien is chief engineer, and Isham Randolph consulting engineer.

Condition of Pure Iron Pipe Siphon in Alkali Soil

R. F. Walter, Supervising Engineer of the U. S. Reclamation Service, Denies Rumors That Pipe Used for Uncompahgre Valley Siphon Is Rusting Rapidly

Pure iron pipe was used for the Uncompahgre Valley siphon of the U. S. Reclamation Service project in Colorado to resist the corrosive action of the alkali in the soil. Since the completion of the work, which was described in the Engineering Record of July 8, 1911, page 41, there have circulated rumors to the effect that the pipe was rusting rapidly. At the suggestion of the American Rolling Mill Company, which supplied the ingot iron pipe, the Engineering Record requested R. F. Walter, supervising engineer, of the U. S. Reclamation Service, to express his views as to the present condition of the pipe. His statement follows:

"The pipe in question, which was made of pure iron, has rusted to a slight extent. It has not failed in any particular and at the rate the rust is entering the iron it will be many years before we have any trouble with it. The pure iron is, however, rusting, and I presume after many years may cause some trouble, but nothing of the kind is evident at this time.

"A small amount of concrete connected with the upper end of this pipe has been affected by alkali, the same being made of sand and gravel secured in the vicinity, which was heavily impregnated with alkali. The other concrete, for which the sand and gravel were hauled from the river, has not been affected. The pipe was coated with asphalt, and at one place, which is the only place it is exposed, I notice that the asphalt coating has deteriorated, probably from the alkali in the ground water."

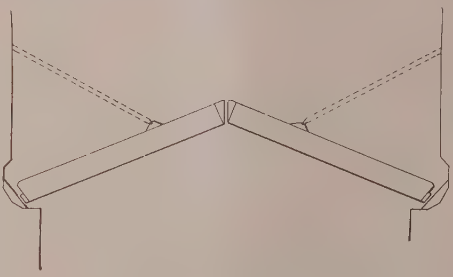
Asphalt Paving on a Plank Base is being used successfully in King County, Washington, particularly for increasing the service that may be expected from roadways supported on wooden trestles. An untreated planked trestle in the vicinity of Seattle wears so rapidly that after about eighteen months of service it has become rough, and the automobile traffic, in particular, avoids it in favor of other routes, although the wear is not yet sufficient to warrant renewal. A 2-in. asphalt wearing surface on a substantial 5-in. plank trestle flooring has been in service for seven years on one of Seattle's main automobile suburban routes, and only moderate patching has been required. The longest service may be secured, it is said, by applying the asphalt when the plank is thoroughly dry, and if this is done the roadway should last, assuming good workmanship, until dry rot destroys the plank.

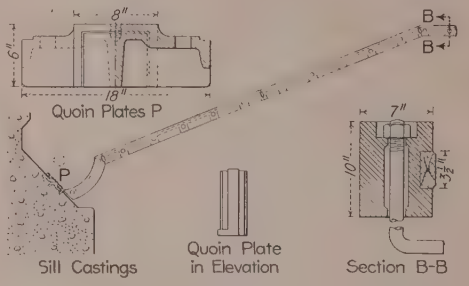
Lock Gates for Dallas-Celilo Canal

Details of Eleven Pairs of Steel Horizontal Girder Type Mitered Gate Leaves 20 to 50 Feet High and 27 Feet Long

The steel lock gates for the Dallas-Celilo canal in Oregon have pairs of massive horizontal-girder mitered leaves which although much smaller than those for the Panama Canal lock gates, are still of unusually large dimensions, involving great care in design, fabrication and erection that is comparable with that of the Panama gates. These gates differ from the Panama gates in dimensions, in details of miter, quoin and sill bearings, in the pintles, in the absence of inner sheathing, air pockets, and the method of operation.

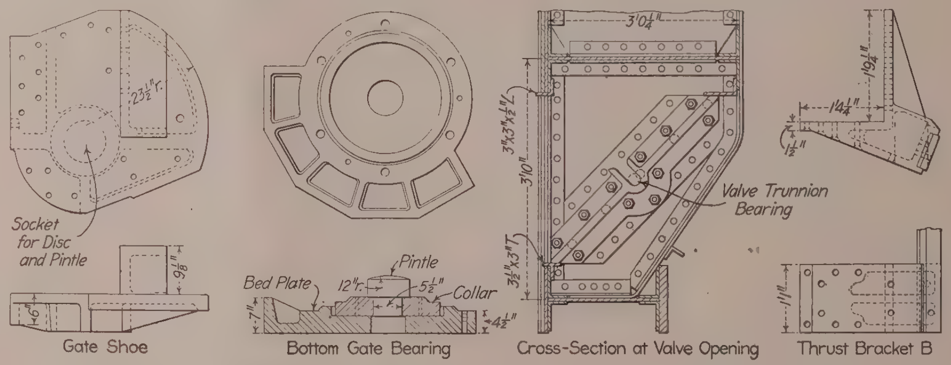
The canal is located along the south shore of the Columbia River between Celilo and Big Eddy, a distance of 8½ mi. There are four locks, requiring ten pairs of leaves beside two leaves for a guard gate at the entrance of the canal. The gates have a uniform length of 26 ft. 11½ in. between centers of bearing surfaces, and heights varying from 20 ft. 5 in. to 49 ft. 11 in. Each of the leaves in six pairs has in the lower part four butterfly-valves closing openings about 2 ft. 8 in. high by 3 ft. 2 in. long, which are commanded by vertical rods operated by rack and pinion from the foot walk on top of the gate. The gates are mounted on top and bottom pintles, the former anchored to the masonry by tension members, and their weight is nearly balanced by the upward pressure of the water on a limited portion of the horizontal projection of the gate. The vertical surface bearings of the gates are all made by accurately finished sectional steel castings fitted to give watertight joints. The gates are operated by horizontal spars pin-con-


PLAN OF MITERING GATES



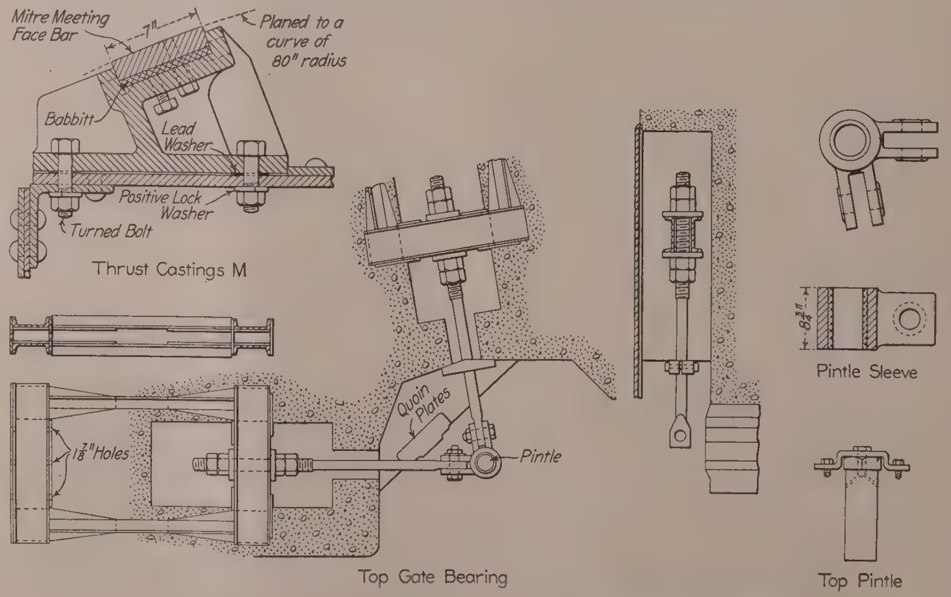
Sill Castings
Quoin Plate in Elevation
Section B-B

SILL WITH DETAIL AND QUOIN PLATES



Gate Shoe
Bottom Gate Bearing
Cross-Section at Valve Opening
Thrust Bracket B

DETAILS OF BOTTOM GATE BEARING AND VALVE OPENINGS THROUGH GATE



Pintle Sleeve
Top Gate Bearing
Top Pintle

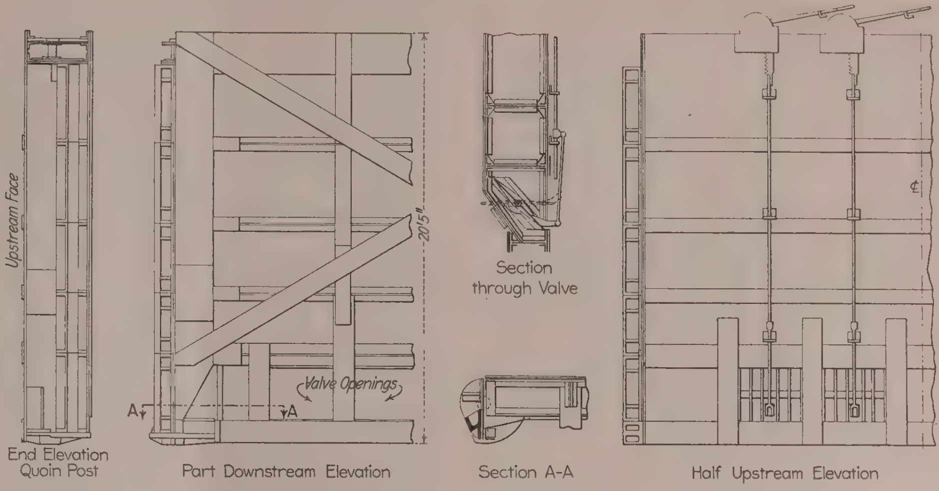
DETAILS OF THE ANCHORAGE AT TOP OF MITERING GATES nected to the upstream surfaces at points nearer the miter post than the quoin post.

GATE CONSTRUCTION

The gates are of the horizontal framed-girder, double-leaf, miter type, straight on both upstream and downstream sides, and have a uniform depth of 3 ft. for all horizontal girders. The girder webs are of varying thickness proportioned for end shear and to afford proper rivet bearing. Usually they are reinforced by stiffeners. The girders are designed for a unit stress of 10,000 lb. in compression and 12,000 lb. in tension.

GIRDERS AND PLATES

The spaces between the horizontal girders are variable and the ends of the web plates are finished to contact with the vertical end plates, which, to insure accuracy, are assembled in the shops before shipment, match-marked, removed and shipped separately. In all gates the bottom girder is reduced in width to allow the gates to overlap the miter sill and expose to the upward pressure at the upper pool a sufficient area to provide for counterbalancing of the weight of the gate. The upstream faces only of the gates are covered with flat plates which extend from center to center of the horizontal girders and are riveted to the flanges of the latter with clearances of ½ in. between the edges of adjacent plates.



ELEVATIONS AND SECTIONS, SHOWING FRAMING OF LOWER GATES

The joints of these plates are spliced and protected by the 13-in. outside flange cover plates of the girders. The thicknesses of the plates were determined by Professor Bach's formula for flat plates under fluid pressure. The downstream faces of the gates are not sheathed, but are X-braced in one or two panels according to height, by 12 x ½-in. flat plates riveted across the flanges of the horizontal girders and two lines of transverse diaphragms, which, with their continuous vertical flange cover plates, practically amount to intermediate vertical girders.

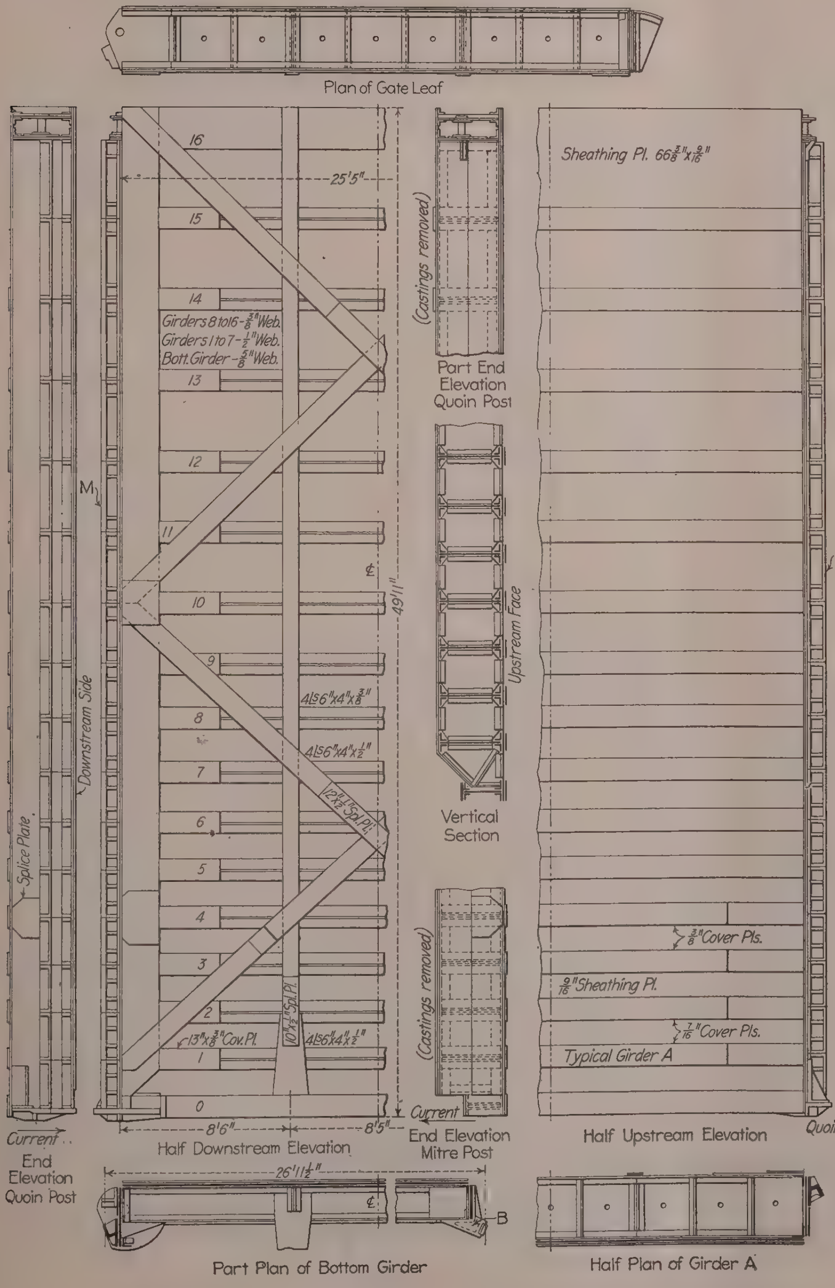
QUOIN, MITER AND SILL BEARINGS

The quoin post is formed by a single heavy vertical sectional cast-steel plate extending from top to bottom of gate and bolted to it to transmit the thrust to the bearing embedded in the concrete hollow quoin. To secure a perfect contact between quoin posts and bearing plates in the concrete, provision was made to bolt the quoin plate to the quoin post bearing during the erection of the gate, and a recess was left in the concrete so that concrete in which the quoin plates are embedded was not placed until the gate was in true position. The quoin plates, 6 in. thick and 18 in. wide, have raised bearing surfaces 8 in. wide, and vary in length from 2 ft. 3 in. to 4 ft. 3 in., corresponding exactly with the lengths of the thrust castings.

The miter post is similar to the quoin post except that for the miter meeting faces a loose steel plate in a slot is provided so that by means of bolts a perfect contact can be obtained for the meeting faces, after which the face behind the adjustable piece is filled with babbitt metal. The faces of the quoin and miter post bearing pieces are slightly curved to prevent nipping at their extreme edges. Sill contact is made by means of a vertical flat steel plate on the bottom girder which bears against structural steel castings on the miter sill. In order to secure perfect fit these castings are not set until the gate is adjusted in position. The miter joint thrust blocks are carried down to the foot of the gate leaf, and where the latter is recessed by the narrower bottom girder they are supported on a special annealed cast steel thrust bracket engaging the end and side faces of the leaf.

BOTTOM AND UPPER PINTLES

An annealed cast steel shoe is bolted to the gate at the foot of the quoin post and has a socket containing a concave phosphor



ELEVATIONS AND SECTIONS, SHOWING FRAMING OF THE UPPER GATES bronze polished disk bearing which engages the spherical top of the steel bottom pintle. The pintle takes bearing on a cast-iron collar with a flanged bedplate bolted to the lock floor.

The upper pintle is a steel pin passing through two horizontal web plates projecting from the quoin post and engaging between them an annealed cast steel sleeve bushed with phosphor bronze and having two lugs pin-connected to horizontal anchor bolts which pass through shallow channels in the masonry and engage riveted reaction yokes embedded in the concrete. These rods are adjustable in both directions by double nuts on both sides of the yoke bearing, and permit the pintle to be shifted in any direction to bring it to vertical alignment with the lower pintle.

Interchangeable Butterfly Valves

The butterfly valves have horizontal axes seated in cast steel bearings bolted to the faces of vertical transverse diaphragms connecting the two lower girders of the gate leaves. All valves are interchangeable and are fitted to reduce the leakage to a minimum.

All riveted steel is thoroughly cleaned of rust and mill scale by sand blasting, and castings are cleaned by scraping and wire brushing, before painting with a mixture of 35-lb. pure red lead to 1 gal. of raw linseed oil, 2 gills of turpentine and 2 gills of Japan drier applied within 24 hr. after mixing. No field riveting was allowed below the third girder of any lock gate and none below the fourth and fifth girders of some gates. The rivet holes for diagonal bracing are drilled in place, and the rivets are field-driven. After connecting the thrust blocks to the quoin and miter posts the holes for the tap bolts are filled with babbitt poured through holes drilled in the castings for that purpose.

The gates contain 1,730,000 lb. of structural steel, 40,000 lb. of forge steel, 420,000 lb. of cast steel, 140,000 lb. of cast iron and 8500 lb. of phosphor bronze and babbitt metal, making a total weight of 2,338,500 lb. The designs were prepared under the direction of Capt. H. H. Robert, Corps of Engineers, U. S. A., and F. C. Schubert, assistant engineer, and were approved by Major Jay J. Morrow. Three bids were opened on May 24, 1913, and the contract was awarded to the Independent Bridge Company, of Alleghany, Pa., for $182,087, which was the lowest bid.

Coethen Sewage-Disposal Plant

A NEW method of handling fresh sludge has been worked out in the sewage-disposal plant recently put into operation at Coethen, Germany. Dr. Edward Bartow recently gave a brief description of the plant before the Illinois Section of the American Waterworks Association. In the bottom are sixteen transverse divisions, each sloping to a trough to which the sediment settles. When the sediment is to be removed a sliding door separates the trough from the upper part of the tank. The opening of a gate on the side of the tank allows the greater part of the sludge to flow out. The balance is drawn out by means of a hoe. The gate is closed, the trough filled with water and the sliding door opened without any disturbance of the liquid above. The effluent from the tank passes to sprinkling filters, which are well constructed with concrete retaining walls. In the center is a specially designed piece of concrete so arranged that the underdrains can be flushed out with a hose as desired. Green algæ were flowing in the effluent drains, showing a very satisfactory purification. Because the plant is new and takes sanitary sewage and storm water, and because comparatively few sanitary connections have been made, opinion is reserved as to its worth. Dr. Dunbar, of the Hamburg Hygienic Laboratory, acted as consulting engineer on the work.

Oneida Street Crossing under Milwaukee River

Three Types of Crossings Considered before Decision Was Finally Made; General Description with Drawings

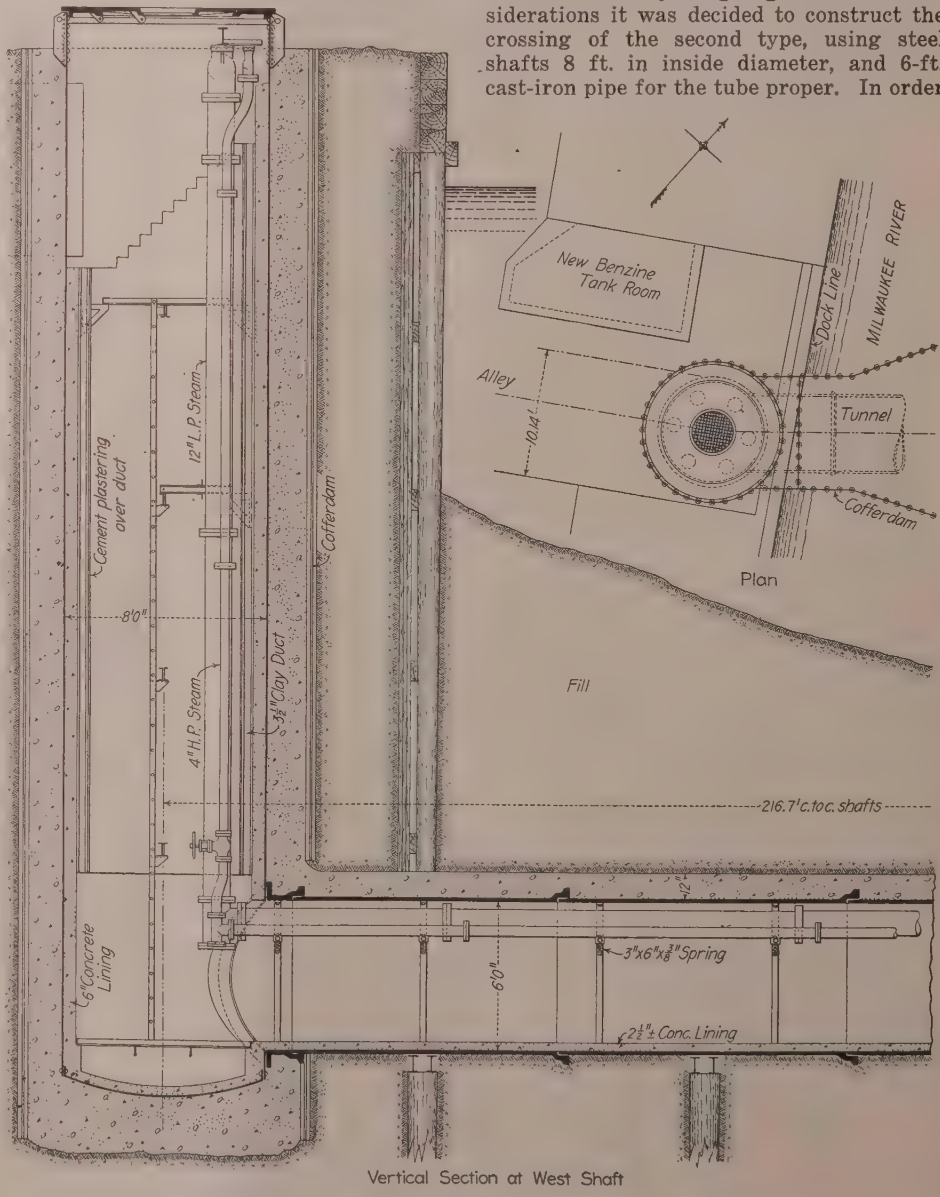
In order to provide connections between the east and west sides of the Milwaukee River, in the downtown district of Milwaukee, for electric cables and steam service mains, the Milwaukee Electric Railway & Light Company is completing a new crossing at Oneida Street under the river to supplement the existing crossings, one of which is near the new tube and another several blocks north, at the Commerce Street power plant.

The three types of crossing considered for this location were (1) submarine cables, (2) steel shafts lined with concrete, connected by a submerged cast-iron pipe crossing, and (3) a driven tunnel constructed under air pressure and fitted with iron or concrete lining. The first type of construction was obviously unsatisfactory, as it made no provision for steam pipes and the cables would be exposed to mechanical injuries. The second, with the cast-iron pipe floated into position and sunk to place in the river bed, presented advantages over the third type in that it had a lower first cost and required less time to construct.

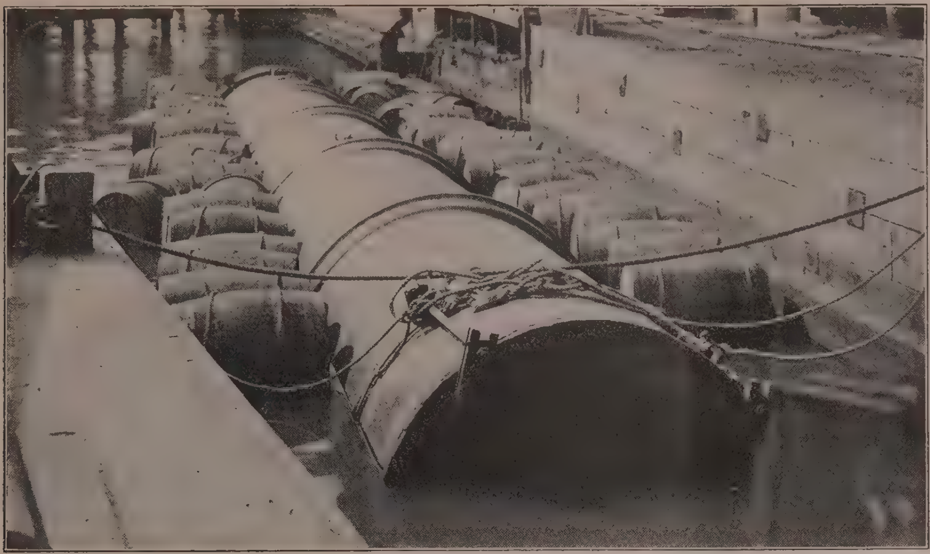
The company now has a connection of the second type located just north of the Oneida Street power plant leading across the river in the same direction as the new tube. It was built in 1898 and is in good condition. It was constructed with 7/16-in. plate steel shafts lined with 8-in. brick walls. The shafts are connected with 4-ft. bell-and-spigot cast-iron pipe, the connecting pipe being entirely filled with conduits. The top of this pipe was placed approximately 22 ft. below U. S. datum, which is about the bottom of the channel at that point. The Government now requires all such obstructions to be placed with a minimum depth of 26 ft. below U. S. datum.

Cast-Iron Pipe Between Steel Shafts

After carefully weighing all of the considerations it was decided to construct the crossing of the second type, using steel shafts 8 ft. in inside diameter, and 6-ft. cast-iron pipe for the tube proper. In order



PLAN AND SECTIONAL ELEVATION OF WEST END OF CROSSING



FLOATING PIPE, SHOWING METHOD OF HOLDING BULKHEADS IN POSITION

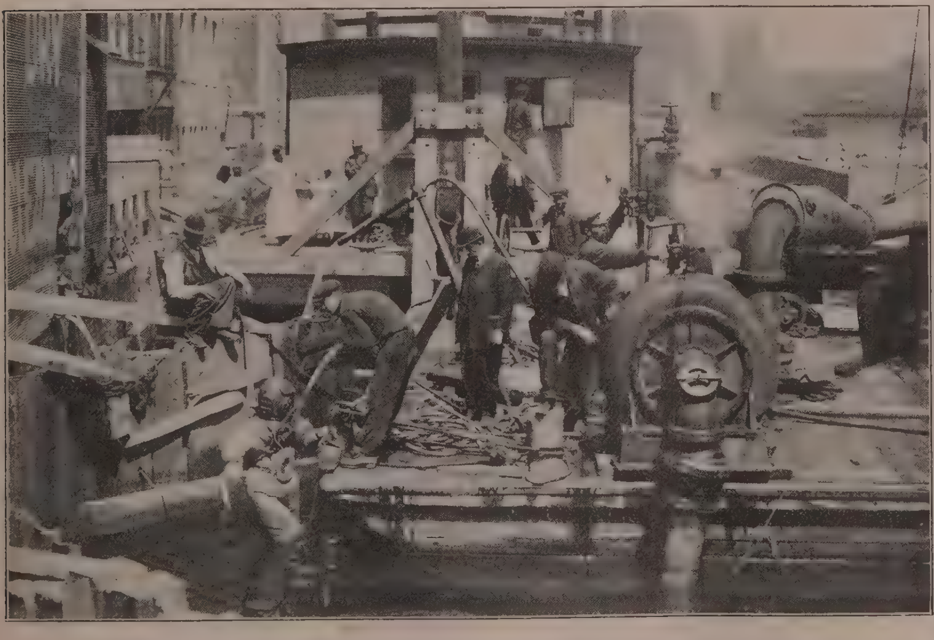
to insure against mechanical injury it was decided to place the top of the pipe at an elevation averaging 29 ft. below U. S. datum and to cover it with a 1-ft. layer of concrete.

Specifications were prepared on this basis and a contract was awarded Feb. 16 for the pipe crossing proper, the company undertaking to furnish the steel shafts, fittings and cast-iron pipe, through other contractors. The contract included placing the shafts and submerged pipe, covering the latter with the layer of concrete, concreting the shafts and other incidental work to be done by the company. Actual work was begun on the ground by the contractor on March 4. Excavations were made for the shafts down to the water level, and at each shaft a circle of 45-ft. interlocking steel sheet piling was driven down to several feet below the bottom of the level of the shafts. The space between the steel sheet piling and the shafts is filled with concrete, and a 6-in. reinforced-concrete lining was placed in each shaft. The top of the pipe was covered with the layer of concrete and the trench backfilled with sand.

The treacherous nature of the river bottom made it necessary to support the submerged pipe for its entire length on pile bents. The pipe was assembled on the ground in lengths of approximately 60 ft., and was floated out and lowered into position by means of heavy chain blocks.

The conduit laid from shaft to shaft is made up of standard 12-ft. sections of 6-ft. cast-iron pipe and one special section differing from standard in that it is constructed with a special bell with two grooves, and the socket is extended back 15 in. Four standard slip joints were used, together with one special slip joint having one of its ends turned 21 in. instead of 5 in., as in the case of the standard slip joint. The special section was laid at the midpoint of the crossing, which is 216.7 ft. in length between center lines of the shafts.

SWIMMING POOLS with sand filters and movable bulkheads have been proposed by Prof. W. S. Franklin, of the Lehigh University. The object is to let the bulkhead push the used water in the pool into the filter, while back of it the pool is refilled with pure water. The bulkhead is built so that it automatically scrubs the bottom and side walls of the pool.



DREDGING SAND FROM AROUND THE PIPE—DIVER PREPARING TO DESCEND

Bacteriological Standard for Water on Common Carriers

Maximum Limits of Permissible Impurity as Fixed by Commission of Experts for U. S. Public Health Service

AS announced in the editorial columns of the Engineering Record of Nov. 21, page 551, common carriers will be required, in the future, to furnish to passengers in interstate traffic water which will conform to a bacteriological standard approved by the Surgeon-General of the U. S. Public Health Service and recommended by a commission appointed for the purpose by the Secretary of the Treasury. The editorial referred to discussed the main features of the new standard. Lack of space prevented the publication in the issue of Nov. 21 of the details of the commission's report. These are given below.

BACTERIOLOGICAL STANDARD FOR WATER

The following are the maximum limits of permissible bacteriological impurity:

1. The total number of bacteria developing on standard agar plates, incubated 24 hours at 37 deg. C., shall not exceed 100 per cubic centimeter; provided that the estimate shall be made from not less than two plates, showing such numbers and distribution of colonies as to indicate that the estimate is reliable and accurate.

2. Not more than one out of five 10-cu. cm. portions of any sample examined shall show the presence of organisms of the bacillus coli group when tested as follows:

(a) Give 10-cu. cm. portions of each sample tested shall be planted, each in a fermentation tube containing not less than 30 cu. cm. of lactose peptone broth. These shall be incubated 48 hours at 37 deg. C. and observed to note gas formation.

(b) From each tube showing gas, more than 5 per cent of the closed arm of fermentation tube, plates shall be made after 48 hours' incubation, upon lactose litmus agar or Endo's medium.

(c) When plate colonies resembling B. coli develop upon either of these plate media within 24 hours, a well-isolated characteristic colony shall be fished and transplanted into a lactose-broth fermentation tube, which shall be incubated at 37 deg. C. for 48 hours.

For the purpose of enforcing any regulations which may be based upon these recommendations the following may be considered sufficient evidence of the presence of organisms of the B. coli group:

Formation of gas in fermentation tube containing original sample of water (a).

Development of acid-forming colonies on lactose litmus agar plates or bright red colonies on Endo's medium plates, when plates are prepared as directed above under (b).

The formation of gas, occupying 10 per cent or more of closed arm of fermentation tube, in lactose peptone broth fermentation tube inoculated with colony fished from 24-hour lactose litmus agar or Endo's medium plate.

These steps are selected with reference to demonstrating the presence in the samples examined of aerobic lactose-fermenting organisms.

3. It is recommended, as a routine procedure, that in addition to five 10-cu. cm. portions, one 1-cu. cm. portion, and one 0.1-cu. cm. portion of each sample examined be planted in a lactose peptone broth fer-

mentation tube, in order to demonstrate more fully the extent of pollution in grossly polluted samples.

4. It is recommended that in the above-designated tests the culture media and methods used shall be in accordance with the specifications of the committee on standard methods of water analysis of the American Public Health Association, as set forth in "Standard Methods of Water Analysis" (A. P. H. A., 1912).

The problem before the commission has been to recommend limits of permissible impurities such as to meet the following requirements:

1. That water supplies conforming to the prescribed requirements shall be free from injurious effects upon the human body and free from offensiveness to the sense of sight, taste, or smell.

2. That supplies of the quality required shall be obtainable by common carriers without prohibitive expense.

3. That the examinations necessary to determine whether a given water supply meets the requirements shall be as few and as simple as consistent with the end in view.

PHYSICAL AND CHEMICAL PROPERTIES

In regard to the physical and chemical properties which render water disagreeable to sight, taste, or smell without producing any concrete harmful effect a difficulty is encountered in that the degree of offensiveness is not accurately measurable, being largely dependent upon individual taste and habits. Again, regarding many of the constituents found in natural waters, as, for example, various mineral salts, it is impossible in the present state of our knowledge to definitely specify the ill effects, if any, which given amounts of these substances may produce. Limits upon these impurities must, accordingly, be so placed as to allow the public an ample margin of safety; but to do this raises the question as to how far it is justifiable to tax the carriers to eliminate impurities whose deleterious effects are so doubtful. This question is the more difficult since it is generally impracticable to remove the mineral salts present in waters by measures of practicable application, and consequently narrow limits to the permissible amounts of such substances will have the effect of eliminating many sources of supply—sources which will frequently be the only ones readily available and may yield waters conforming with entire satisfaction to the other more important sanitary requirements. Finally it is in regard to permissible amounts of mineral constituents that the greatest difficulty is encountered in framing such requirements as shall require only simple methods of examination for their enforcement.

It is because of these difficulties and because of the minor sanitary importance of regulating the chemical impurities of water supplies that these questions have been left for further discussion and this report drafted to deal only with the more important question of regulating bacteriological impurities.

The limits recommended for permissible pollution of this character are as rigid as it is possible to make them without, on the one hand, requiring absolute freedom from such bacteria or, on the other hand, increasing materially the cumbersomeness of the examinations necessary to ascertain compliance with the requirements. Compliance with the requirements herein recommended will insure a quality of water supplies equal to that of municipal supplies which have been demonstrated by experience to be entirely safe and satisfactory and will at the same time impose no great burden upon common carriers, since it is entirely practicable, with moderate expense and pains, to purify water to the degree required.

In submitting the recommendations herewith presented it may be again emphasized that the limits defined are recommended with reference solely to the special object of the control of the supplies of common carriers, having in mind that these supplies constitute a special case because of the following three principal reasons:

1. The supplies come from widely diversified and mixed sources.

2. Samples taken from common carriers represent waters stored for various lengths of time under varying conditions.

3. In view of the impossibility of accurately ascertaining the source and history of each supply examined reliance must be placed upon results of laboratory examination to a greater extent than is necessary or justified in estimating the quality of a supply from a known source with a known history.

Economical Duty of Pumps

Analyses of Costs of Pumps and Pumping Engines, and Comparisons Between Special Tests and Every-Day Station Duty

By FRANK H. CARTER

Assoc. M. Am. Soc. C. E.; Designing Engineer, Cambridge, Mass.

THE chief purpose of this discussion is to show that under ordinary circumstances high-duty pumps are the most economical. For small units and for special cases where the manufacturer can offer a reduction in price because he has previously made a pump very similar to the one required, the formulations herein derived may be far from the truth.

The late C. A. Hague, in a paper presented May 17, 1911, before the American Society of Civil Engineers, gave the following estimate of what condensing pumping engines should cost for a capacity of 1,000,000 gal. in 24 hr.:

(1) Compound, low duty	$2,300
(2) Low-duty, triple, horizontal	2,800
(3) Cross-compound	3,300
(4) High-duty, triple, vertical	4,800

The costs include foundations, piping and appurtenances, but not buildings, chimneys, wells or boilers. The first two engines are direct-acting machines; the third and fourth are of the crank and flywheel type. The cost of boilers, with mechanical stokers, feed pumps, steam piping and appurtenances, ready for service, under average conditions would be covered, according to Mr. Hague, by $20 per horsepower. The averages are based upon a total water load against plungers of 90 lb. per square inch, or a head of 207 ft., including friction.

Comparison with bids on pumps of recent dates shows that these prices are perhaps 10 per cent low. Adding this percentage, therefore, and assigning certain values as the probable range of test duty of the class indicated, we have Table 1.

TABLE 1—ESTIMATED COST OF PUMPING ENGINES PER 1,000,000-GAL. CAPACITY

Type	Cost	Test duty million ft. lb. per 100 lb. of coal
(1)	$2,530	25-60
(2)	3,080	40-80
(3)	3,630	70-110
(4)	5,280	125-170

TABLE 2—BID PRICES AND ESTIMATED COSTS OF PUMPS FOR GIVEN CAPACITIES AND HEADS

Capacity, million gal. per day	*Total head, lb. per sq. in.	Test duty, million ft. lb.	Estimated cost	
			Bid price	By formula
1.50	130	105	$5,400 5,270 6,310	$7,500
5.00	133	120	38,500	29,500
5.00	125	125	30,000	27,500
4.00	125	120	15,900	21,500
5.00	125	125	18,936	27,300
5.00	125	125	20,250	27,300
5.00	125	130	19,500	28,200
1.57	119	104	6,635	7,250
1.57	...	88	5,375	6,350
2.15	123	105	7,950	10,300
2.15	...	89	6,450	9,150
2.15	126	85	6,688	9,000
2.15	...	115	13,750	11,200
1.57	...	110	9,918	7,950
2.15	115	112	10,800	10,300
....	...	110	16,280	10,100

*Total head includes suction and friction.

The cost of a pump must of necessity vary according to some function of p, the water pressure on the water and that exerted by the pump. According to a designing engineer employed by one of the leading pump manufacturers, the cost of pumps may be assumed to vary roughly as the 0.8 power of the total dynamic water pressure, including suction, friction and static heads. By tentative trials it is found that the above costs, exclusive of a consideration of any variation with respect to the dynamic head may be expressed by formula, using the maximum duty allowance under the head "test duty," $C = 115x^{0.75}$; or, adding the function expressing the variation of cost of the pump as a power of the total water head p, assuming $p^{0.75}$ for ease in computation, $C = 115x^{0.75}\ (p/90)^{0.75}$, as the costs given are for $p = 90$ lb. Reducing this formula to simpler terms, $C = 3.94\ (xp)^{0.75}$.

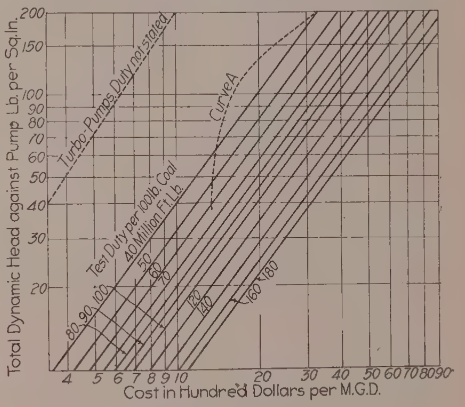


FIG. 1—ESTIMATED COST OF STEAM PUMPING ENGINES

Curve A is another curve said to represent rate of variation of cost of reciprocating pumping engines pumping against head.

This is graphically shown in Fig. 1, where C = cost per million gallons capacity; x, test duty in million ft. lb. per 100 lb. of coal; p, total head, including suction, friction and static pressure.

It is, of course, difficult if not impossible to formulate the cost of pumping engines

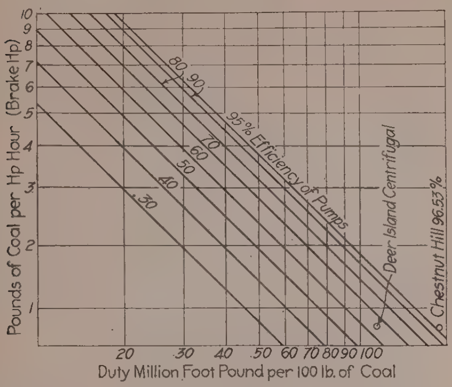


FIG. 2—DUTY OF PUMPING ENGINES

Figured per pound of coal per brake horsepower with various efficiencies of pumps.

with any degree of certainty, owing to one fact at least, and that is, that one manufacturer may possess complete patterns of the type, size and pressure required, while all competitors may be required to figure the cost of entirely new patterns. It is interesting, however, to compare a number of actual bids with the estimated costs as derived by the formula and shown in Table 2. An examination of this table will demonstrate the fact that it is absolutely necessary to obtain estimates or perhaps even formal bids from the pump manufacturers before attempting to fix finally upon the most economical duty. To illustrate what may be done, however, to determine a reasonable value for the economical duty under given conditions, we may, in the absence of actual estimates of cost or bids from manufacturers of pumps, proceed as follows:

Mr. Hague gave tabulated values of the boiler horsepower required for each pump horsepower, counting 10 sq. ft. of heating surface per boiler horsepower. These are listed in Table 3, from which it is easy to show that the cost of boilers per 1,000,000-gal. capacity is $\$540/D$, where D is the duty.

TABLE 3—BOILER HORSEPOWER IN TERMS OF PUMP HORSEPOWER

Duty per 1000 lb. of dry steam, million ft. lb.	Boiler horsepower per pump horsepower
40	1.63
50	1.32
60	1.10
70	0.94
80	0.83
90	0.74
100	0.66
110	0.60
120	0.55
130	0.51
140	0.47
150	0.44
160	0.41
170	0.39
180	0.37
190	0.35
200	0.33

This expression is derived as follows, using 1,000,000 gal. daily = 1.55 sec.-ft.

$$1.55 \times 62.4 \times 60 \times p \times 2.30/33{,}000 = 0.407p \text{ horsepower}$$

or the theoretical or water-end horsepower involved in pumping water is $p(0.407)Q$, where Q is daily capacity in million gallons.

For a duty of 80,000,000 ft. lb. per 100 lb. of coal, the cost of boiler plant will be $0.83 \times 0.407p \times \$20 = 6.75p$ in dollars. By tentative methods it is found that this cost may be expressed as a formula $C = \$540p/D$ per 1,000,000-gal. capacity. The annual cost of coal for fuel, based on 8-hr. pumping on station duty basis, may be formulated as $\$350Qpa/x(3/4)3 = 155.5Qpa/x$, where Q = daily capacity in million gallons; p, dynamic pressure in pounds per square inch, including all losses; a, cost of coal in dollars per ton of 2000 lb.; and x, duty in million foot pounds per 100 lb. of coal. The expression is derived as follows:

$$Q \times 8.33 \times p \times 2.3/D = L/100$$

where L = coal consumed in pounds. Thus

$$L = Q \times 8.33 \times p \times 2.3 \times 100/D$$

(see Table 4 and Fig. 2). Assuming cost of coal per ton to be a, the annual cost becomes $1910Qpa \times 365/2000D = 350Qpa/x$, assuming a 24-hr. test duty. As the plant or station duty is about 75 per cent of the test duty, the actual cost of the 8-hr. pumping per day is

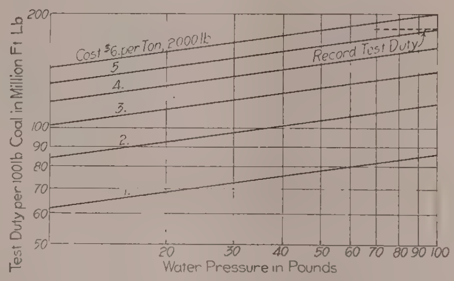


FIG. 3—ECONOMIC DUTY OF PUMP ENGINES

Based on test duty and assuming plant duty equal to three-fourths of test duty.

$$350Qpa/\tfrac{3}{4} \times 3 \times x = 155.5Qpa/x$$

From these three formulæ an expression can be derived for the economical duty of a pumping plant.

$$\text{Cost of pumps} = Q \times 115(xp/90)^{0.75} = 3.94Q(xp)^{0.75} \text{ in dollars}$$

$$\text{Cost of boilers} = 540pQ/x \text{ in dollars}$$

Annual cost of coal in dollars $= 155.5paQ/x$ and, therefore, the cost in dollars per million gallons, capitalizing the cost of coal at 4 per cent, is

$$C = 3.94(xp)^{0.75} + 540p/x + (155.5pa/x)25$$

TABLE 4—RELATING TO DUTY

Duty per 100 lb. coal, in million ft. lb.	Coal in lb. per million gal. raised 1 ft. dynamic	Coal in lb. per horse-power-hour	Boiler ft.-lb. per pump horsepower as per Hague	Gal. raised 1 ft. per lb. of coal	Steam consumption per horse-power-hour
10	83.3	19.8	....	12,000	198.0
15	55.5	13.2	....	18,200	132.1
20	41.6	9.9	....	24,000	99.0
25	33.3	7.93	....	30,200	79.3
30	27.7	6.61	....	36,300	66.1
35	23.7	5.67	....	42,800	56.7
40	20.8	4.95	1.63	48,000	49.5
45	18.3	4.40	....	54,700	44.2
50	16.6	3.96	1.32	60,300	39.6
55	15.1	3.61	....	66,300	36.0
60	13.9	3.31	1.10	72,000	33.0
70	11.9	2.83	0.94	84,200	28.3
80	10.6	2.48	0.83	94,500	24.8
90	9.25	2.20	0.74	108,000	22.1
100	8.33	1.98	0.66	120,000	19.8
110	7.57	1.80	0.60	132,000	18.0
120	6.95	1.65	0.55	144,000	16.5
130	6.41	1.52	0.51	156,000	15.2
140	5.95	1.41	0.47	168,000	14.1
150	5.56	1.32	0.44	179,000	13.2
160	5.11	1.236	0.41	192,000	12.4
170	4.91	1.165	0.39	203,000	11.6

1 hp = 33,000 × 60 = 1,980,000 ft. lb. per hour.

Water-end horsepower for 2,500,000 gal. per 24-hr. day = 1 hp per pound water pressure (error of 1 or 2 per cent).

TABLE 5—COMPARISON BETWEEN PUMPING ENGINE TESTS AND EVERY-DAY STATION DUTY, METROPOLITAN WATERWORKS, BOSTON

Test duty, some on steam and some on coal basis, in ft. lb	Plunger displacement	Plant duty to test duty, in per cent
103,347,500	....	..
105,164,600	65,310,000	63
150,045,000	104,710,000	69.5
176,051,500	141,840,000	80.5
158,574,000	....	..
154,815,000	107,750,000	70.5
158,750,000	....	..
172,405,000	126,860,000	79.2
115,959,370	....	..
60,727,400	....	..
	Average	71.5

Capacity, million gallons per day	Station duty, 1911, in million ft. lb.	Average lift, ft.	Q, million gal. daily	Test duty
		Deer Island		
100	...	...	...	112,800,000
45	...	...	...	93,761,971
45	52.6	10.95	52.8	95,867,476
45	...	...	...	....
		East Boston		
100	...	...	...	109,000,000
45	...	...	...	91,104,390
45	62.1	15.53	50.8	92,458,975
45	...	...	...	....
		Charlestown		
22	...	...	...	92,025,790
22	55.6	8.3	32.6	87,420,358
60	...	...	...	....
		Alewife Brook		
4.5	...	...	...	....
4.5	16.9	12.77	3.012	....
13.0	...	...	...	....
		Ward Street		
50	79.4	40.31	22.6	152,719,000
		Quincy		
3	32.942	21.24	4.069	....
5	...	...	...	....
10	...	...	...	....

Assuming an interest charge of 4 per cent, maintenance charges of 2 per cent for pumps and 5 per cent for boilers, sinking-fund charges of 3 per cent for pumps and 5 per cent for boilers and a charge of 1 per cent for oil waste and packing against the pumps, we have yearly charges of 10 per cent for pumps and 14 per cent for boilers. The above formula may then be written

$$C = \frac{3.94}{10}(xp)^{0.75} + \frac{14 \times 540p}{100x} + \frac{155.5pa}{x}$$
$$= 0.394(xp)^{0.75} + (75.5p/x)\ (2.06a + 1)$$

Differentiating,

$$\frac{dc}{dx} = \frac{\tfrac{3}{4} \times 0.394p^{0.75}}{x^{0.25}} - \frac{75.5p}{x^2}\ (2.06a + 1)$$

Placing $dc/dx = 0$,

$$x = 23.6p^{1/7}(2.06a + 1)^{4/7}$$

assuming 8 hr. of pumping at a daily rate in million gallons of Q. This equation is shown in diagrammatic form in Fig. 3.

To illustrate further the economy of high-duty pumping engines, the diagram by the late Freeman C. Coffin is published herewith. This was presented to the writer some ten years ago while engaged with Mr. Coffin in designing part of the Newburyport waterworks system, and is published here for the first time by permission of Lewis D. Thorpe, his successor (see Fig. 4).

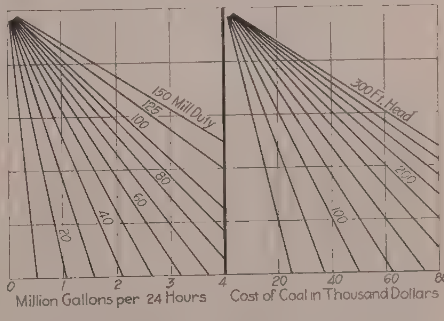


FIG. 4—DIAGRAM FOR FINDING COMPARATIVE ECONOMY FOR PUMPING ENGINES OF DIFFERENT DUTIES

It is now well known that the every-day plant duty of a pumping station will not realize the test duty within about 25 per cent. This is clearly demonstrated by Table 5, which shows the relation of test duty and plant or station duty on the Boston Metropolitan waterworks system during 1910 and 1911.

The station or plant duty is affected very largely, of course, by the fact that fires have to be banked between pumpings. The amount of coal required to bank a fire when the boiler is performing no work is a quantity which varies with the condition of the boiler setting as to leaks in the draft, tightness of the damper, and, perhaps, other matters of construction of the boiler. Three instances at the Metropolitan waterworks at Boston when careful records were kept on coal required for bank fires gave the data in Table 6. These are first-class installations under the best of care and supervision, and yet the results are far from uniform. Some authorities allow 0.5 lb. per horsepower-hour for banking fires under average conditions. The banking of fires between pumpings is but one of the causes of difference between test duty and station or plant duty. A test duty is made under what might be termed laboratory conditions, with every feature of pump and boiler at its best, while the plant duty is the every-day average state of affairs.

TABLE 6—COAL REQUIRED TO BANK FIRES

Average pumping		Per cent of total time during which fires are banked	Coal in lb. per horsepower-hour required for banking fires
Q million gal. daily	hp		
30.5	875	52.5	0.045
30.1	675	9.5	0.15
8.5	180	31.2	0.13

The introduction of the high-duty steam-turbine-driven unit as a competitor of the standard high-duty pumping engine requires that a careful study be made into the economy of this type of machine, because of both its much lower first cost and consequent lower fixed charges, and the much smaller building required. There is also a strong probability that the turbine-driven unit will require fewer attendants, with a resulting saving in the labor charges.

South America as a Field for American Engineers

Dr. Bailey Willis Discusses Opportunities in Topographic Surveying, Railroad Building, River and Harbor Work, and Irrigation

THAT the American engineer is the one best qualified to organize progress in South America is the belief of Dr. Bailey Willis, consulting geologist to the Argentine Government, as expressed Nov. 19 at the banquet of the Washington Engineers' Society. With the exception of insignificant areas and of long lines of traverse along rivers or boundaries between States the South American continent is unsurveyed and its topography unknown. It will be the work of 50 years, according to Dr. Willis, to make such maps of the more accessible parts of South America as are being made of the United States, and the work can be done better and at less cost by the topographers trained in the methods of the United States Geological Survey than by any others. They have not their equals in efficiency and skill among the topographic engineers of the world.

There are surveys being made, especially in the three A B C countries. In Brazil Dr. Derby, the American geologist, has made a beginning. In Argentina the army engineers are carrying out a very costly geodetic survey with subordinate topographic work, and of certain areas there are useful maps made by the organizations temporarily carried on under Dr. Francisco P. Moreno, the great Argentine geographer.

In Chile there is a bureau of surveys which is executing a triangulation, slowly extending topographic maps and allotting Indian lands. But in all these countries, as well as in those which are even less advanced, there is urgent need of the American topographer and efficient economical map-making to lay the essential foundation of all engineering projects—to make the topographic map.

RAILWAY BUILDING

Railway building attracts more attention than any other form of engineering in South America, and reasonably so, because there is great need of railways. Brazil, for instance, with an area equal to that of the United States, is not as far advanced as the United States was in 1860, so far as the penetration of railways from the Atlantic to the interior is concerned. Our western termini were then already beyond the Mississippi. The ends of the railroads that radiate from Rio and Santos have progressed relatively no further than Cleveland and Cincinnati, and between their present terminal points and La Paz in the Andes of Bolivia, the central point of Pacific lines, stretches the vast plateau and plains country of the Paraguay basin, equivalent in width to the distance from Ohio to Salt Lake, Utah.

A French-Belgian syndicate has been building the Brazilian Northwestern, directed from Sao Paolo toward La Paz. It has reached the crossing of the Upper Parana. An American and foreign syndicate directed by Mr. Farquhar has secured control in southern Brazil, Paraguay, Uruguay, and Northeastern Argentina, and is planning to link up the disjointed sections by a system of trunk lines, including the Atlantic Coast line connecting Rio, Santos, Montevideo, and Buenos Aires, and a line directed westward from Santos to Paraguay. The chief engineer, Mr. Shaw, upon whom falls the responsibility of designing the great strategic lines of the Farquhar system, began his career thirty years ago on the surveys for the Northern Pacific in the Territory of Washington, and has brought to his task a rare combination of daring American with the canny Scotch nature, fortified by abundant experience and lightened by a keen sense of humor. It happened some eighteen months ago that the French chief engineer of a foreign locating party left the work and Mr. Shaw took over the foreign subordinates. They were ready to quit but not one did, and recently when Mr. Shaw left the field they gave him a hearty testimony of respect and affection. We need more men like Mr. Shaw.

In Argentina the capital invested in railways already amounts to a billion dollars, and by far the larger proportion of that amount is English money. The Great Southern and the Great Western have extended a network of lines over the rich provinces, which constitute the heart of the Argentine Republic, and radiating from Buenos Aires in every direction south of the Rio de la Plata, they control the immense productive hinterland of that metropolis.

With these companies the American engineer has no chance, but he may console himself with the thought that railway building on flat plains is not a very desirable professional opportunity. In the northern part of the Republic of Argentina the American-managed Brazil Railway Company is extending its connections, and in the southern part, in Patagonia, as well as in the northern territories, there are Argentine Government lines under construction. On these works there is room and need of American ability.

In Chile, out of 4000 mi. of railroad 2000 mi. belong to the State, and in that country we find an independence of foreign engineers unusual in South America, the State railways having been built through very difficult country by railway locators of Chilean birth and training.

The American railway engineer will find the field in any South American country already occupied by men who are his peers in railway location and construction. They can build a finished road as well as he can; but he has over them the one advantage of having learned to lay the rails, get the traffic, and subsequently build the road as it pays. His first task is to prove that that can be done and dividends be earned by the American way, where European engineering would lead to bankruptcy.

HYDRAULIC ENGINEERING

In hydraulic engineering South America offers an immense field. Although notable works have been built in such harbors as Santos, Montevideo, Buenos Aires, and Valparaiso, they and others are quite inadequate for the growing shipping and invite the development of comprehensive projects looking to even greater future needs. The navigable rivers already surveyed and buoyed by the Argentine and Brazilian governments throughout more than 3000 mi. present problems in maintaining deep channels for ocean going steamers far into the continent and adequate ones for inland navigation. The interior basin in which the Paraguay and its many branches head, comprising parts of western Brazil, Bolivia, and Paraguay, is an immense alluvial plain comprising an area larger than the vast plain of eastern China, so recently studied by the American engineers for the Red Cross. There will eventually develop in South America a demand for the reclamation of the regions now annually flooded, and Holland will be outdone by the works that will be built.

The districts in which the irrigation engineer will find work to do extend down the west coast through Peru and as far as Santiago, and on the eastern slope of the Andes there is a very extensive semi-arid region in Argentina where the waters of the great Cordillera will be completely absorbed in the irrigable land. Irrigation is an ancient art in South America, and in modern times much has been done to develop its possibilities. The greatest work of the kind is under construction by the Argentine Government on the Rio Negro, having been carried nearly to completion by Italian, Scotch and English engineers. But there still remain vast possibilities and abundant opportunities for the experience and initiative of American engineers to promote the development of those far southern countries as they already have that of our great West.

Road Building with Industrial Equipment

Twelve-Car Train Hauled by a 20-Horsepower Dinkey Successfully Operated on Eastern Shore of Maryland

AN example of the application of narrow-gage railway equipment to road work was shown in constructing a 12-mi. concrete highway between Whaleyville and Parsonburg, on the eastern shore of Maryland. About 40,000 tons of materials were handled at a complete unit price of 15.86 cents per ton-mile, of which the actual hauling cost figured 10.52 cents.

The road parallels the tracks of the Baltimore, Chesapeake & Atlantic Railway, the distance between the two never being more than 0.7 mi. This greatly facilitated the handling of material and it was found advisable to build private sidings at five points, reducing the maximum haul by the industrial locomotive to 2½ mi. At the siding in use at the time sand and stone were delivered to the trucks from bottom-dump railway cars by means of a Galion Eclipse unloader, which has a capacity of ten 40-ton cars per 10-hr. day. Cement was transferred in bags at about the same point. The new road consists of 1:2:4 concrete slabs 14 ft. wide, 5 in. thick at the edges and 7 in. at the center.

Besides the length of the road, there are three particular circumstances favoring the use of the narrow-gage plant. These are the flat character of the country, the location through a new territory, and the loose, sandy soil, which offers high tractive resistance to wagon tires. The maximum loads may be carried practically everywhere —there are no grades over 1 per cent—and there is no traffic to delay operations.

EQUIPMENT USED

The plant included 12,000 ft. of 20-lb., 2-ft. straight track, 225 ft. of curved track, three 75-ft. turnouts, thirty-six 1½-yd. cradles, a platform car and a 20-hp dinkey locomotive. The hauling figures in the accompanying table are based upon the locomotive handling a train of twelve cars carrying 20 tons per trip. This train was used in some instances for hauls as short as ½ mi., but the average haul was 1.5 mi. and the average number of trips per 10-hr. day for this distance was seventeen. The cost data, therefore, are computed on a basis of 510 ton-miles per day.

The table indicates all the labor required for the handling of aggregates and cement except the three workmen who formed the track-laying gang. These men, with no other tools than wrench and crowbar, laid on the average 1200 ft. of track a day. The track comes in 15-ft. lengths, bolted to steel cross-ties 32 in. in length. The weight of the track sections for the 20-lb. rail is 270 lb. It was of course necessary to move the track several times, principally to run to the five sidings successively used, and the combined figure of 1½ cents for laying and picking up is based upon the expenses of the three workmen for handling 64,000 ft.

Though the side-dump cars are designed to throw material well to one side of the track, so much stone was required per 100 ft. that after depositing it the track had to be cleared partly and shifted about 6 in. to allow the sand cars to pass. To meet this local condition required the services of seven workmen, which accounts for the unusually large labor charge.

LONG TANGENT ON COMPLETED ROAD

The completion of the 3¾-mi. section from Whaleyville to the Pocomoke River required forty-three working days between April 20 and July 15. Work progressed faster on the 8-mi. section, which was finished Oct. 13. To complete the entire contract required 125 working days, and this number has been used in getting the daily cost for freight and track-handling charges.

A MILE OF STONE AND SAND READY FOR USE

DAILY EXPENSE FOR 510 TON-MILES

			Cost in cents per ton-mile	
Hauling				
Labor				
Engineer	$4.50		0.88	
Fireman	3.50		0.69	
Seven laborers unloading	14.00		2.74	
Foreman	3.00		0.59	
Total		$25.00		4.90
Fuel—ten 5-mi. trips at 20 cents.........		10.00		1.96
Maintenance and renewal — 20 per cent annually of $10,000, divided by 200 days.		10.00		1.96
Freight—$125 divided by 125 working days		1.00		0.20
Laying and removing 64,000 ft. of track at 1.5 cents, divided by 125 days		7.68		1.50
Total for hauling...		$53.68		10.52
Loading (elevator)				
Foreman	4.25		0.83	
Five laborers	10.00		1.96	
Gas engine runner....	2.75		0.54	
Fuel	1.25		0.25	
Maintenance and renewal — 20 per cent of $1000, divided by 125 working days...	1.60		0.32	
Total for loading...		$19.85		3.90
Superintendence and office charges, 10 per cent		$7.35		1.44
Total for hauling and loading		$80.88		15.86

DINKEY AND CARS AT ELEVATOR

The number of days used and the average use made throughout a year of the elevator unloader were introduced in corresponding fashion in computing the cost of that equipment.

Of the 40,000 tons of materials hauled, 19,930 were stone and 9475 sand. The remainder was distributed among forms, cement and miscellaneous supplies. These were bulked in the records, as they were handled so irregularly that it was not practicable to itemize. A large quantity of cement, for instance, was usually held at the sidings because it was not desirable to deliver it farther than a day's run ahead of the mixer. The aggregates could be deposited without this limitation, and it was economical to move the elevator when the limits of haul were reached, making the delivery of much of the cement by wagon. The industrial equipment was of the Koppel type. The road was built by the McNerney Construction Company of Canton, Pa., of which M. J. McNerney is general manager. Frank H. O'Rourke was superintendent of construction.

Handling 400 Tons of Stone per Day with Auto Trucks

Maryland Road Contractor Operated a Five-Truck Fleet Twenty-four Hours a Day, with Unit Cost of 8.28 Cents per Ton-Mile

FOUR hundred tons of crushed stone per day were hauled 4 mi. with auto trucks for a waterbound-macadam State highway recently constructed from Lisbon to the south branch of the Patapsco River, in Maryland. The trucks, of which there were five, were employed 24 hr. a day, and the contractor states that the stone was handled for 8.28 cents per ton-mile.

The stone was delivered in bottom-dump cars to the Baltimore & Ohio Railroad siding at Mt. Airy Junction, where it was unloaded with a bucket elevator which received the stone in a pit beneath the track. The trucks are rated at 4 tons each. The labor required for each of the 12-hr. shifts comprised two workmen at the elevator and one driver for each truck. An extra driver was included in the organization. The average time required for a truck to make a round trip for the average haul, 4 mi., was 1 hr. and 10 min.

The trucks were engaged fifty-four working days and cost records were kept during this interval for all the equipment. These are given in the accompanying table. Each truck made on the average twenty trips per day, carrying 4 tons and covering 8 mi. per trip, 4 mi. loaded and 4 mi. empty. The work done every day was therefore 1600 ton-miles, the figure used in deriving the unit charges.

To operate each truck 1 mi. cost 4¾ cents

DAILY EXPENSE FOR 1600 TON-MILES

			Cost in cents per ton-mile
Hauling			
Labor			
Ten drivers	$30.00		
Extra driver	3.50		
Four laborers unloading	8.00		
Total		$41.50	2.6
Fuel and lubricant — Five trucks making twenty 8-mi. trips at 4¾ cents		38.00	2.37
Maintenance and renewal—20 per cent annually of $20,000, divided by 250 working days		16.00	1.0
Total for hauling		$95.50	5.97
Loading (at elevator)			
Gas engine runner	3.00		
Four laborers	8.00		
Fuel	10.00		
Maintenance and renewal—20 per cent of $2000, divided by 100 working days	4.00		
Total for loading		$25.00	1.56
Superintendence and office charges, 10 per cent		$12.05	0.75
Total for loading and hauling		$132.55	8.28

for oil, which has been multiplied by the total daily mileage. Depreciation, interest and repair charges have been lumped for both equipments under the heading "maintenance and renewal." The fleet of trucks represents an original investment of $20,000, against which an annual capital charge of 20 per cent—$4000—has been made. This amount has been divided into the 250 working days during which the contractor is able to use the trucks, to obtain the unit figure, 1 cent per ton-mile. The contractor uses his trucks during the winter for general hauling in the South, which permits the practically continuous use indicated in the unusual number of working days per year. He is well satisfied with the performance of the equipment and believes that the items of the cost have been fairly determined.

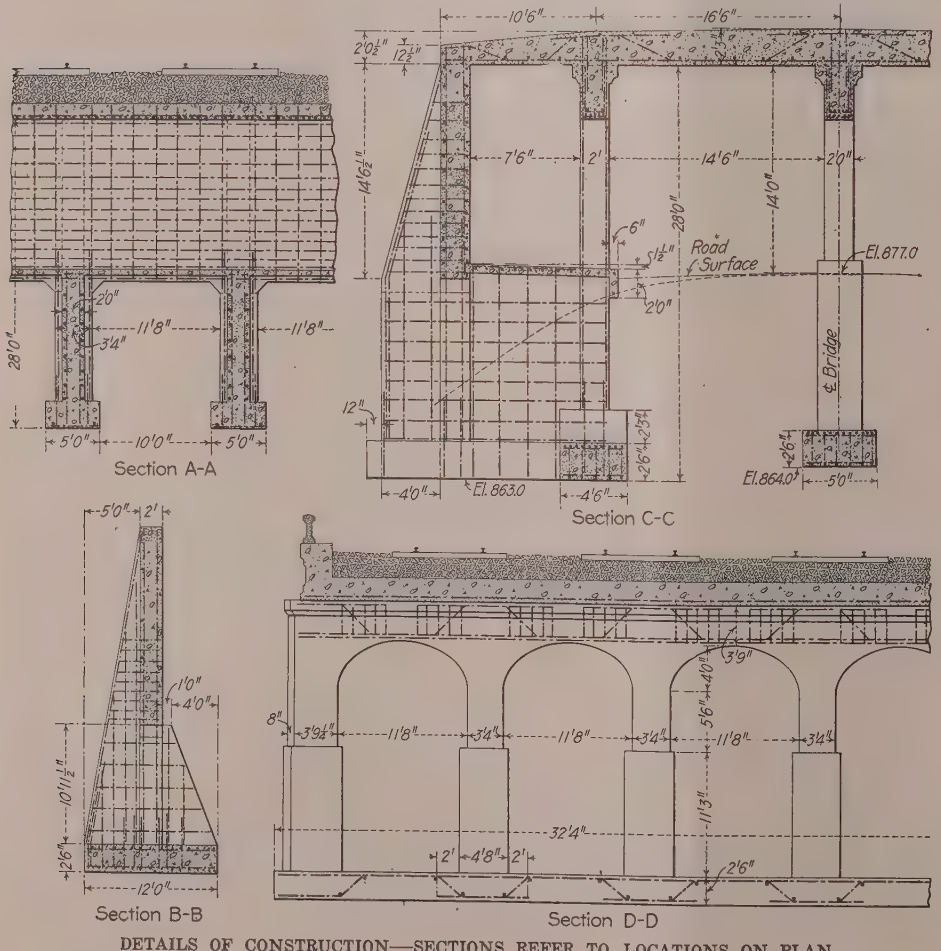
It has been observed that for the sand roads over which it is necessary to haul on the eastern shore of Maryland the 4-ton machines are the most efficient. The fleet consists entirely of Packard trucks. James B. Clark, of Ellicott City, Maryland, is the contractor. The road was completed Oct. 14.

Reinforced-Concrete Bridge with Cantilever Abutments

Overhead Crossing at Hallstead, Pa., on the Delaware, Lackawanna & Western Railroad, Has Many Novel Features

A REINFORCED-CONCRETE overhead railway crossing with cantilever abutments has been built over Church Street at Hallstead, Pa., in connection with the relocation and straightening of the main line of the Delaware, Lackawanna & Western Railroad, between Clarks Summit and Hallstead. The crossing is on a heavy skew—50 deg. 21 min.—and the gap to be bridged measures 50 ft. on a line perpendicular to the abutments. The bridge carries four tracks, 13 ft. on centers, placed on a 200-ft. spiral of a 2-deg. curve.

Because a concrete bridge was proposed, permission was obtained to construct piers in the center of the roadway and at each curb. This allowed the structure to be designed as a reinforced-concrete slab, for which, otherwise, the span would have been prohibitive. The gaps to be bridged, therefore, are 16 ft. 6 in. between piers and 8 ft. 6 in. between piers and abutments. The street is placed on an 8-ft. fill, necessitating an excavation of about 13 ft. for the foundations. The soil in the bottom of the excavation was found capable of carrying with safety 3 tons per square foot, and the foundations were designed accordingly.



DETAILS OF CONSTRUCTION—SECTIONS REFER TO LOCATIONS ON PLAN

As the headroom desired was 14 ft., the abutments had to be made 28 and 26 ft. high respectively in order to reach down through the fill. Gravity-section abutments would have required large foundations with a big toe to reduce the maximum pressures to 3 tons per square foot, and their yardage would have been large. Reinforced-concrete, therefore, was decided upon. Counterforts were carried down to the foundations, while the facing walls were stopped below the sidewalk to lessen the horizontal pressure on the abutment. Below the sidewalk the counterforts, which are spaced 15 ft. on centers, have been extended to the pier along the curb. This gives added stiffness to the structure and limits the cantilever action to the upper 14 ft. 6½ in.

Facing walls have not been figured for vertical beam action over the span of 15 ft. between supports, as their depth will permit arching stresses. The stresses due to horizontal beam action were taken care of by reinforcement, and the slab was considered as a continuous beam with a maximum moment (positive or negative) of $WL/10$ at center and supports. Equal amounts of reinforcement were provided at both faces. This eliminates bending the steel to take care of negative moments. Two-tenths per cent of extra reinforcement was provided for temperature stresses.

The combined foundation for the abutment and the pier consists in plan of a series of T-shapes. The foundation for the pier is continuous and forms the top of the T, while the counterforts are supported on the stems. The bearing on the soil is uniformly distributed, as the T has been so dimensioned that the resultant of the load passes through its center of gravity.

Between counterforts and below the sidewalks the fill has been tamped to enable it to resist the pressure from the fill back of the abutment. Furthermore, the concrete surfacing of the sidewalk has been reinforced against possible upward pressures due to impact from trains on the fill. The counterfort reinforcement has also been carried up into the sidewalk slab to anchor it.

PIERS

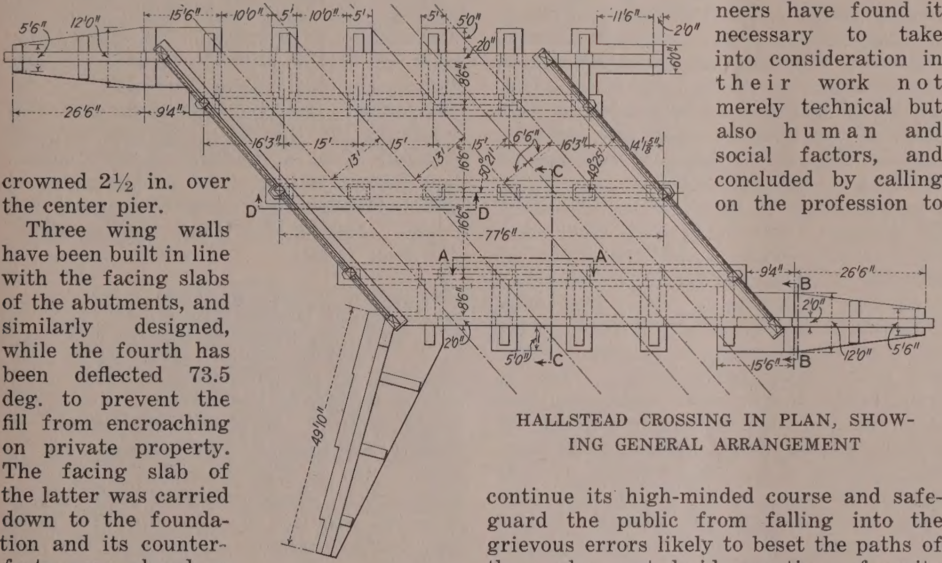
To save concrete and reduce the load the piers have been designed as rows of columns, six in each. They are supported on continuous foundations, 4 ft. 6 in. wide for the curb piers and 5 ft. for the center pier. All columns are 2 x 3 ft. 4 in. in cross-section, except those at the ends of the piers, which are 2 x 3 ft. 9½ in. and have been provided with 8-in. noses, as shown in the accompanying illustration.

At the top of each row of columns there is a girder 3 ft. 9 in. deep. For architectural reasons this girder has been designed to form with the wide columns a series of elliptical arches. As the analysis of these arch beams is somewhat indeterminate, each span of 11 ft. 8 in. was designed for a moment of $wl^2/8$ and the same amount of steel bent up over the supports to take care of probable negative moments.

FLOOR SLAB

The floor slab was considered as spanning the perpendicular distance between piers. The slab load was figured as uniformly distributed and equal to the maximum possible loading from an engine of the Mikado type, approximating Cooper E-60 loading. The additional load due to impact was figured by the expression $L^2/(L+D)$, where $L =$ live load and D, dead load. It was assumed that the roadbed would distribute the load uniformly over a strip 13 ft. in width. As the tracks were placed 13 ft. on centers the assumption as to the probable loading of the slab was justified. This method of loading, in connection with the assumed action of the slab, left triangular areas at the sides of the bridge without support, and the parapet was, therefore, designed to support these areas.

As there were spans of two different lengths and it was desired to design the slab as a continuous beam, the part over the shorter span was tapered from a thickness of 2 ft. ½ in. to 1 ft. ½ in. to save concrete without disturbing the continuity. To facilitate drainage the slab has been crowned 2½ in. over the center pier.



HALLSTEAD CROSSING IN PLAN, SHOWING GENERAL ARRANGEMENT

Three wing walls have been built in line with the facing slabs of the abutments, and similarly designed, while the fourth has been deflected 73.5 deg. to prevent the fill from encroaching on private property. The facing slab of the latter was carried down to the foundation and its counterforts were placed on the rear. The others have facing slabs extending only to the sidewalks. On the rear the counterforts extend to the top of the slabs, while in front they stop below the ground line, as shown in one of the illustrations.

No expansion joints have been provided, as such were deemed unnecessary. The permissible unit stresses were 650 lb. per square inch for concrete in compression and 16,000 lb. for steel in tension.

The structure was designed in the engineering department of the Delaware, Lackawanna & Western Railroad, under the supervision of G. J. Ray, chief engineer, and A. B. Cohen, concrete engineer. It was built by the W. H. Gahagan Contracting Company under the supervision of F. L. Wheaton, engineer of construction, and L. G. Krause, resident engineer.

BLASTING FROZEN BULK FREIGHT, such as sand, clay, rock ballast or ore, is recommended in the October issue of the DuPont Magazine. The following directions are given: Use a slow-acting dynamite in small quantities, say one-fourth or one-half of a 1¼ x 8-in. cartridge per charge. Make a hole with a crowbar in such material as broken stone, and with an auger in sand or clay. The charge should be not less than 2 or 3 ft. from the side or bottom of the car. Tamp the hole when loaded and fire the charge preferably with an electric detonator, although a blasting cap and fuse may be used. It is stated that the material may be opened up in this way without damage to the cars and without throwing the material.

Engineers as Arbiters of Public Equity and Justice

Interstate Commerce Commissioner Praises Work of the Profession, Particularly with Reference to Relations between Utilities and the Public

"IN all this varied and complex matter of public administration the engineering profession has evidenced its ability to grasp these problems of public equity and justice." In these unqualified terms and in this spirit, W. M. Daniels, member of the Interstate Commerce Commission, paid a remarkable tribute to engineers at the annual banquet on Nov. 19 of the Washington (D. C.) Society of Engineers. He showed how engineers have found it necessary to take into consideration in their work not merely technical but also human and social factors, and concluded by calling on the profession to continue its high-minded course and safeguard the public from falling into the grievous errors likely to beset the paths of those who must decide questions of equity as between corporations and the public.

Mr. Daniels' address follows:

HUMAN AND SOCIAL PROBLEMS

It is interesting to note that in its evolution from the status of an exceptional employment to that of a recognized profession, engineering has been forced, little by little, to take account of other laws and forces than those of mathematics and physical science. Primarily designed to effect certain well defined technological results, it has increasingly had to take account of economic and social considerations, of the fluctuation of prices and price levels, and of varying rates of pecuniary return. Besides mathematics, it has had to study markets; besides excavation, it has had to study sanitation; besides strength of materials, it has had to study strength of motives to save and invest; and thus eventually engineering has been forced to embrace within its horizon the age-long problem of the Sphinx—the ascertainment and the quantitative appraisal of matters relating to justice and equity between man and man.

This last demand which has been imposed upon the engineer has been particularly manifest where engineering has been enlisted in problems of public administration. First, this was shown in the simple problems involving condemnation proceedings, where private property was taken by the State under the law of eminent domain, where the engineer was called upon to make his estimate in order to protect against confiscation the individual whose property was taken.

Next in order, the engineering profession has been called upon to afford, in the more complex problems of tax appraisals and assessments, a verdict to determine the relative measure of tax obligations as between individual taxpayers in their entirety on the one hand, and great corporations on the other.

Going one step farther, in the domain of government regulation of public utilities, the engineer has been called upon to furnish a just basis on which to predicate the approval of security issues. Here the respective interests of the corporation, the consumer, and the investor have been weighed in the engineering scales.

And last of all and most important of all, we have had to resort to the engineer for the data indispensable in the fixing of just and reasonable rates for the services rendered to the public by various public utilities.

ENGINEER NOT A SATELLITE OR RETAINER

In all this varied and complex matter of public administration the engineering profession has evidenced its ability to grasp these problems of public equity and justice. Nor do I know of any justifiable basis for the allegation that the engineering profession has shown evidence of a bias in its solution of these problems by reason of the prevailing employment of the engineer in earlier days mainly by private interests. The most frequent, the most painstaking and the most illuminating discussions of these very problems involving relative claims of the public as against corporate interests are to be found in engineering literature, engineering reports, and engineering discussions. The economist certainly has no monopoly of vision into the just relationship between public and private interests, and certainly is not warranted in assuming an attitude of Olympian infallibility and graciously extending to the engineer the permission to act as a satellite and humble retainer.

A very interesting example of how the engineer is inevitably drawn into the human and social problem of effecting equity and justice between man and man is found in the very important, and as yet imperfectly solved, problem of valuation for rate-making purposes.

VALUATION

While there are many competing bases for valuation purposes having rate-making as their end, the two cardinal antithetical bases around which all others may be grouped seem to be Original Cost to Date as against Present Value.

I shall not even attempt to adjudicate between the conflicting claims of these two bases. But it is interesting to note that in neither case has it been possible to prevent the intrusion of alien elements of a social and ethical import. The advocates of Original Cost are generally free to admit that the cost in question is not necessarily the actual cost, not what the property did really cost to build, but what it should have cost had it been produced with due consideration for honest and economical construction. Cost is thus denaturalized, as it were, and is transformed into what is termed *normal cost*. Nor is the metamorphosis even then complete. Even normal cost, if it has produced a property which disappoints the promoters' expectations and affords a service which the public will not buy at a price yielding the ordinary return upon the outlay, is relegated to the discard, and *efficient cost* is substituted in its place—that is, a cost which has justified itself by its results. Original Actual Cost is thus transformed into Normal Efficient Cost—possibly a more equitable basis, but one so changed from Original Actual Cost that its own mother would never recognize it.

In other words, the theory which starts from the standpoint of setting up original actual outlay as a value-basis suffers a "sad sea change," and emerges as a theory which accords acknowledgment only to an investment made by the light of prudent and sagacious foresight. Extravagant outlay is consigned to the limbo of the nondeserving. Even prudent outlay in the original investment has its pretensions disallowed unless the investment proves justified by furnishing a service for which consumers stand ready to pay sufficient to accord a profitable return. Not *actual original expense*, but such expense as was originally made with what, with our superior hindsight, we allow as economic prudence, and with what, with achieved results, we now admit was made with commendable economic foresight, is to be accorded a claim to a return. It is not, therefore, actual sacrifice, work, abstinence, or investment, or the amount of any one of them, which on this theory is entitled to consideration, but it is past prudence plus present effectiveness which is entitled to reward. The efficiency of past investment is gaged by the presence of a present return of profit. And yet this anomalous transformation still bears the name of Original Cost. The past fact is gaged in the light of present knowledge, and both by the standard of present day efficiency; and this transformed entity carries its misleading ancestral title of Original Cost. The social and ethical overlay has entirely transformed the original factor.

PRESENT-VALUE BASIS

But the competing basis of Present Value, that is, cost of reproduction less depreciation, does not upon analysis fare much better when judged in the light of logical consistency.

In the first place, the unit prices which are employed are admittedly not the current market prices, but average prices, the period for averaging being taken with a degree of arbitrariness, as, for example, five years. But whatever the period taken, and however persuasive the reasons for the average from a standpoint of justice, it is on the very threshold an admitted departure from the Present Value which it purports to represent.

Then, not infrequently another modification of literal present value is made on the basis of, not the reproduction cost of the actual property now existing, but of such a property as would now be constructed by enlightened engineering to afford an equal or a comparable service. If we proceed by disallowing increment value or appreciation upon certain parts of the property, or allow such appreciation up only to a certain period in the past, and if the value of reproducing the business as distinct from the plant is gaged not on the actual pioneer basis, but on the basis of the readier enlistment of patronage that would today be required, we get a transformed value basis which it may suit our purpose to call Present Value, but which departs therefrom so frequently and so radically that the name is, literally, a misnomer. In other words, various threads of social equity have so crossed and recrossed our original web that the finished fabric is about as much like literal present reproduction value as an antique tapestry is like modern broadcloth.

SOCIAL FACTORS CANNOT BE NEGLECTED

In short, valuation for rate-making purposes is a process which cannot and does not escape all kinds of considerations of society equity and justice. We may begin, we must begin, with an inventory of physical quantities; we may multiply them with a carefully averaged list of market prices, but we must inevitably end with a conspectus of just social and human requirements as measuring the relatively equitable claims of the public interest as over against private and corporate interests.

Just a word of warning in conclusion. The Present-Value basis, even when estimated on an average of unit prices for the past few years, seems very likely to result in a value basis notably higher than original cost. Actual construction prices in the past were in general upon a notably lower level than similar prices today. There is grave danger that in aligning for one basis as against the other we may be swayed, not by full and fair consideration of the competing claims of the two methods, or their various elements, but by the probable likelihood of their respective results. It is a poor argument for the correctness of any particular method that it is likely to produce a result in accordance with our preconceived wishes or desires. The engineering profession must school itself and must show others how to avoid this temptation, must conduct us to such clearly reasoned considerations of social equity, balanced with considerations for the maintenance and perpetuation of future service efficiency, that the result will compel the acceptance of fair-minded, enlightened and equal-dealing public opinion.

Book Reviews

The first printed report of the State Water Commission of California has been issued. It reviews briefly the work accomplished by the commission since its creation two years ago and contains a summary of applications for permits filed for the use of State waters.

Malleable iron shoes for continuous stave pipe are shown and described and hydraulic tables and useful formulæ for the calculation of wooden pipe lines are given in a 135-page, 4½ x 7-in. clothbound book issued recently by the Marion Malleable Iron Works, of Marion, Ind. The book is of the same type as the Carnegie and Cambria handbooks and will be as useful to pipeline engineers as these books are to structural engineers. Able co-operation in the preparation of the book, so as to make it as useful as possible, has been secured from Robert E. Horton and Enrique Touceda. On page 129 there is a list of manufacturers of continuous stave pipe and the pages following contain advertisements of most of the firms listed. The first part of the book shows and describes shoes, washers and tank lugs, and gives tables of sizes, after which follows a report on continuous stave pipe by Robert E. Horton, containing much data on design, and tables for minimum and maximum spacing of bands, sectional area of bands per inch length of pipe for different sizes and spacing of round steel bands, relative discharging capacities of wood-stave and other pipes, comparison of velocities and capacities of wood-stave pipes according to different formulæ, friction heads, velocities and discharges of wood-stave pipes by the Moritz formula, and heads due to velocity $h = v^2/2g$. After a chapter containing standard specifications for malleable-iron castings and tables of weights of such castings there follow specifications for pipe bands with tables of dimensions and weights. The Moritz diagram for flow of water in pipes is reprinted from the Engineering Record of Dec. 13, 1913, with a brief synopsis of its use. The remainder of the book contains general hydraulic data, a diagram showing allowable spacing of hoops for tanks, tables of feet and inches and tables of squares and cubes. (Marion, Ind., The Marion Malleable Iron Works.)

"Surge Tank Problems" are discussed in a 27-page, 9 x 12-in. pamphlet published by E. R. Weinman and D. R. Cooper. The pamphlet is an authorized translation of articles written by Prof. Franz Prasil of the Eidgenössische Teknische Hochschule at Zürich, Switzerland, and has appeared in serial form in the "Canadian Engineer." After a brief introduction the derivation of principal equations is dealt with. The main part of the booklet consists of modifications of these equations because of special features involved, such as sudden shutdown, sudden opening and variable outflow, and tanks involving spillways. Each case is analyzed both analytically and graphically and accompanied by a numerical problem. The diagrams illustrate well the surges in the tank for each of these cases. The case involving spillways deals with the two cases when the top of the tank itself acts as a spillway and when the spillway is located at a different point on the main conduit. This chapter ends with a summary giving a bird's-eye view of the influence of the various factors that enter the problem of wave action in surge tanks. At the end of the pamphlet are two appendices—A, dealing with surge tanks of variable cross-sections, and B, simplified and approximate formulæ for the determination of surge tanks with constant cross-section. The latter appendix is written by A. Strickler and affords a convenient method of making preliminary investigations. The derived formula gives the required area of a surge tank for a given maximum surge and reads

$$A = \frac{av_1^2}{2g} \times \frac{2L}{(z_{max} + h_1)\, z_{max}}$$

where A = area in square feet, v_1, normal velocity of water in the main conduit in second-feet, during period of steady flowing; g, gravity; L, length of main conduit in feet; h_1, friction head corresponding to pipe dimension and velocity v_1, and z_{max}, vertical distance between tops of maximum surge and static level in tank. The formula gives results from 1 to 3 per cent too large, but is accurate enough for preliminary computations. The treatise here offered is the best and clearest on surge-tank phenomena so far published in the English language and the pamphlet will be a welcome addition to the library of every hydraulic engineer. (E. R. Weinman, 114 West 80th Street, New York City, 50 cents, net.)

The U. S. Geological Survey has recently issued Water-Supply Paper 363, 137 pages, "Quality of the Surface Waters of Oregon," by Walton van Winkle; Water-Supply Paper 332-C, 226 pages, "Surface Water-Supply of the United States, 1912—Part 12, North Pacific Coast Drainage Basins—Part C, Lower Columbia River and Rogue, Umpqua and Siletz Rivers," by F. F. Henshaw and E. S. Fuller; and Water-Supply Paper 340-C, pages 31 to 42, "Stream-Gaging Stations and Publications Relating to Water Resources, 1885-1913—Part 3, Ohio River Basin," by B. D. Wood.

FILTERS AND FILTER PRESSES. For the Separation of Liquids and Solids. From the German of F. A. Buhler, with additional matter relating to the theory of filtration and filtration in sugar factories and refineries. By John Joseph Eastick. Cloth, 7 x 10 in.; 184 pages; 327 illustrations. London, Norman Rodger. 12 shillings net.

(Reviewed by George A. Johnson, 150 Nassau Street, New York.)

The book describes at length and with profuse illustrations a large number of machines and materials which are on the market for use in the industrial arts. Parts I and II are devoted to filters and filter presses and Part III gives a general description of the art of sugar filtration, including more description of apparatus and extolling upon the virtues of Kieselguhr (an aid to filtration). Part III also gives the specifications of an assortment of patents and an appendix furnishes a list of patents granted in the United Kingdom relating to filters, filter presses, etc. The book should be of considerable value to manufacturers as a compilation of information regarding available machinery, especially that of foreign make. Its main purpose appears to be that of the trade catalogue.

A TREATISE ON THE LAW OF MECHANICS' LIENS AND GENERAL CONTRACTING OF THE STATE OF NEW YORK, WITH FORMS. By Thomas H. Ray, of the New York City Bar. Canvas, 6½ x 9½ in.; 706 pages. Albany, N. Y., Matthew Bender & Co. $5 net.

(Reviewed by George A. King, of the Bar of the Court of Claims, Washington, D. C.)

This book is of wider scope than might appear from its title. While it is written from the New York standpoint and but few cases outside of that state are referred to, it is nevertheless applicable to building contracts and in large measure to mechanics' liens in every part of the country. A useful appendix consists of forms for mechanics' liens and the text of the New York mechanics' lien law.

The first part of the book covers in brief compass about the same ground as John C. Wait's valuable book on engineering law. That, however, was published in 1897, and as no new edition has appeared, it has become somewhat out of date on account of the enormous number of important engineering decisions given by the courts in the seventeen years that have elapsed since its publication. Such a large proportion of the engineering decisions of the country now come from the State of New York that there is hardly a better general summary of the existing American law of engineering contracts than can be found in the first part of this work. While it is primarily a law book, its pages might well be read and mastered by builders and contractors with great interest and profit.

The mechanics' lien law is emphatically a people's statute, often acted upon without the aid of a lawyer. Its provisions are interpreted by the courts in a broad and liberal spirit. A contractor or material man, often only with the aid of a clerk of court, puts his lien on file, leaving for the services of a lawyer only subsequent proceedings in court to enforce the lien if the owner of the building fails to meet the obligation for which the lien is filed. It is largely for this reason that, as was stated by the U. S. Supreme Court, "statutes giving liens to laborers and mechanics for their work and labor are to be liberally construed." Indeed, the New York statute expressly lays down this rule for its own construction: "This article is to be construed liberally to secure the beneficial interests and purposes thereof."

The author has treated his subject clearly and has often stated the important points of the decisions to which he refers in the very language of the courts.

The most useful chapters of the book to the lawyer in general practice will be those relating to "Performance in General," "Time of Performance," "Certificates and Arbitration" and "Extra Work and Specifications." It is in these chapters that the principles of law peculiar to engineering and building contracts are most strongly emphasized. Such contracts are drawn in a peculiar form, differing from contracts in general. The clauses usual in these contracts on the powers of the engineer, extra work, terms of payment, etc., have acquired a settled meaning through repeated decisions of the courts. The rules applicable to them are thus quite different from those prevailing in ordinary contracts of commercial life, in which the two parties stand on something nearer an equal footing.

These chapters cannot be too carefully read or considered by contractors engaged in carrying out contracts or by general practitioners of the law when considering any of the questions constantly arising under an engineering contract between the owner and the contractor as to their respective obligations. The book is heartily recommended as a valuable practical manual for the engineer and contractor, as well as for the lawyer.

Letters to the Editor

Use for Pulverized Slate

SIR: We have a customer owning a slate quarry containing thousands of tons of high-grade slate. It is easier and cheaper to quarry in small pieces. Cannot this slate be pulverized and used for some purpose, or can it be mixed with some other ingredient or ingredients and compressed into roofing shingles, building, pavement or fire bricks? Perhaps some of your readers can offer a suggestion.

CODD TANK & SPECIALTY COMPANY,
Baltimore. Wm. C. Codd, President.

Investigating Youngstown Building Collapse

SIR: In your issue of Nov. 7, there is an article headed "Investigating Youngstown Building Collapse." In this article the statement is made that Alpha Portland cement was used. This is a mistake. The cement used in the structure which failed was not the Alpha brand. While this is true, our own people have made some investigations in regard to the matter and are satisfied that the fault was due to the fact that the supporting forms were removed before the concrete had properly set.

G. S. BROWN,
Second Vice-President, Alpha Portland Cement Co.
Easton, Pa.

Water Discoloration Caused by Gold Dredge

SIR: We have had considerable trouble at Tin Cup, Colo., with our gold dredge causing a discoloration of the water of Willow Creek. We have wondered if you could give us any information regarding clarification of the water in the dredging pond. This water now runs through several hundred feet of tailings, but is not clear when it emerges.

The trouble caused seems to be simply a discoloration of the water, which extends a number of miles down this stream and on into other streams to which it is tributary, causing a cloudy effect in the water which is objectionable to fishermen, as the trout will not rise for fly fishing.

Considerable objection has been made to our discoloring the water, and we are very anxious to find a solution to the problem. We think you might be interested in this phase of gold dredging, or that you might have had something of the kind brought to your notice previously.

THE TIN CUP GOLD DREDGING COMPANY,
Denver. By Royal D. Salisbury, Mgr.

[Possibly some reader of the Engineering Record can throw light on the problem.—EDITOR.]

Rational Methods and Guesswork in Sewer Design

SIR: In your issue of Oct. 17, page 420, you ask for a reason for the general practice of designing sewers so that they will flow half full when receiving the estimated maximum amount of water. I am not aware that this practice is general, and I know of no good reason why the practice should be general. However, there are conditions under which such a design may be desirable and reasonable. Where property is very valuable and where the damage of an overflow would be very great, it is a reasonable proposition to allow a factor of safety so that sewers will not overflow in case of an exceptional storm which might exceed the expectation of the designer.

Where sewers are necessarily shallow and it is desirable to hold the plane of high water as low as possible, it may be wise to design sewers so that in times of maximum rainfall the depth of water in the sewer will be 60 or 70 per cent of the diameter of the sewer. At the present time the city of Chicago is building a large system of relief sewers with an outlet trunk 9 ft. in diameter. The relative capacity of this sewer when full will be about 50 per cent. greater than the relative capacity of existing sewers after they are connected with this relief sewer. In other words, in times of rainfall, when the existing sewers will be full without pressure, the depth of water in the relief sewer will be about two-thirds of the diameter of the sewer.

I believe it has been the general practice to design sanitary sewers so that they will flow half full under the average condition of the fully developed territory, that is, so that the average flow during the day would fill the sewers half full. The purpose of this is to provide sufficient capacity for the maximum flow during the day or during particular days when more than the usual amount of water is used. It is assumed that the maximum rate during a short period of time is about twice the average rate during the day.

C. D. HILL,
Engineer, Board of Local Improvements.
Chicago.

Enforcement of Wisconsin Building Code

SIR: Regarding the enforcement of the Wisconsin building code, the penalty for violation is provided in the Industrial Commission law inclosed. In the reference to this penalty in the introduction to the building code the word "will" might have been used instead of "may." Probably the idea in the back of my head in writing this sentence as I did, was that the commission would probably not seek to enforce this penalty for some minor violation due to ignorance. The penalty is, however, mandatory, as you will notice from the law inclosed.

In the larger cities and towns we expect to enforce the code largely through the co-operation of city officials, as indicated in our introduction and as required in the law inclosed. We hope to have this co-operation take the definite form of appointing a city building inspector (or conferring the duty of building inspector upon some existing official), and requiring city building permits, as is already the case in Milwaukee, Superior and Madison.

In presenting this matter to city officials, we put it on a strictly business basis and show how building regulation is the most rational and efficient protection against the conflagration hazard. We have just started this phase of our work and have so far found city officials receptive to this idea. If we do not meet with reasonable co-operation we may have to ask the Legislature to pass a law requiring cities to appoint building inspectors and require building permits. We shall first, however, make every effort to secure this co-operation voluntarily. In the smaller cities and villages we shall have to depend on our own deputies, together with more or less assistance from the fire chief. Here we may eventually have to seek a requirement for State building permits for the larger buildings. We think it best to proceed very slowly in this direction and be quite sure of our ground, because such a requirement would probably meet considerable opposition.

Whatever success this commission has had in connection with the workmen's compensation act and in the field of accident prevention has been due to its endeavor to secure results by education and co-operation rather than by arbitrary regulation.

INDUSTRIAL COMMISSION OF WISCONSIN,
Per Sidney J. Williams, Building Inspector.
Madison, Wis.

[The section of the law referred to is appended.—EDITOR.]

Section 2394—70. If any employer, employee, owner or other person shall violate any provisions of sections 2394—41 to 2394—55, inclusive, of the statutes, or shall do any act prohibited in sections 2394—41 to 2394—71, inclusive, or shall fail or refuse to perform any duty lawfully enjoined, within the time prescribed by the commission, for which no penalty has been specifically provided, or shall fail, neglect or refuse to obey any lawful order given or made by the commission, or any judgment or decree made by any court in connection with the provisions of sections 2394—41 to 2394—71, inclusive, for each such violation, failure or refusal, such employer, employee, owner or other person shall forfeit and pay into the state treasury a sum not less than ten dollars nor more than one hundred dollars for each such offense. It shall be the duty of all officers of the State, the counties and municipalities, upon request of the Industrial Commission, to enforce in their respective departments, all lawful orders of the Industrial Commission, insofar as the same may be applicable and consistent with the general duties of such officers.

Anchoring Base Plates for Columns

SIR: In your issue of Oct. 17, page 441, there is an article entitled "Anchoring Base Plates for Columns." The theory, with the equations worked out therein, is similar to that I used in a letter appearing in the Engineering Record Jan. 17, 1914, page 86, entitled "Design of Reinforced-Concrete Retaining Walls." In that letter I gave three elementary equations, which express the same conditions used in the article in the issue of Oct. 17. Instead of proceeding to solve the example analytically, which would have involved a cubic equation, I showed how the same results could be obtained by a cut-and-try method. This cut-and-try method could also be used for bolts to anchor columns, and I will show how the results check with the results as given in the article in the issue of Oct. 17. Referring to Figs. 1 and 2 of that article the data assumed for the example were a base plate with $h = 80$ in.; b, 40 in.; a, 8 in.; M, 6,000,000 in.-lb., and R, 30,000 lb., making p 200 in. It was also assumed that the bolt stress was not to exceed 12,000 lb. per square inch at the root of thread.

To solve this problem the first thing is to determine the value of x. In the analytical method it is necessary to solve a cubic equation. This either requires going through an algebraic process, which probably not more than one in fifty engineers can do without reviewing their algebra, or to assume trial values and see if the equation is satisfied. It has been my experience that this way requires not less than three or four trials and often more. To avoid this assume any value at random for x, usually about $h/3$ to start with, and then determine the stresses in the concrete and the bolts. Applying this in the above problem assume first that $x = 24$ in. D will then be 168 in. from R and 64 in. from Z. Then

$$Z = (168/64)\ 30{,}000 = 78{,}570 \text{ lb.}$$

$$D = 78{,}570 + 30{,}000 = 108{,}570 \text{ lb.}$$

and $\sigma = 108{,}570 \times 2/24 \times 48/24 = 226.2$ lb. per square inch. Hence the unit stress in the bolts $= 226.2 \times 15 \times 48/24 = 6786$ lb. per square inch, which is too low.

Assume that $x = 18$ in.; D is then 166 in. from R and 66 in. from Z. Then

$$Z = (166/66)\ 30{,}000 = 75{,}455 \text{ lb.}$$

$$D = 75{,}455 + 30{,}000 = 105{,}455 \text{ lb.}$$

and $\sigma = 105{,}455 \times 2/18 \times 40 = 292.2$ lb. per square inch. Unit stress in bolts $= 292.2 \times 15 \times 54/18 = 13{,}150$ lb. per square inch, which is too high.

Now assume x to be the interpolated value

$$24 - [(12{,}000 - 6786)/(13{,}150 - 6786)] \times 6 = 19.17 \text{ in.}$$

D will then be 166.39 in. from R and 65.61 in. from Z. Then

$$Z = (166.39/65.61)\ 30{,}000 = 76{,}080 \text{ lb.}$$

$$D = 76{,}080 + 30{,}000 = 106{,}080 \text{ lb.}$$

and $\sigma = 106{,}080 \times 2/19.17 \times 40 = 276.7$ lb. per square inch. Unit stress in bolts $= 276.7 \times 15 \times 52.83/19.17 = 11{,}440$ lb. per square inch. This is probably as near as necessary on account of the limitations of stock sizes of bolts. The area required at root of thread of bolts $= 76{,}080/11{,}440 = 6.652$ sq. in., or if two bolts are used, 3.326 sq. in. in each. Two 2⅜-in. bolts have a cross-sectional area of 6.6 sq. in. and will serve all right.

It may be seen from the foregoing that this solution is a better and quicker way than to solve the cubic equation for x. The value of x for the third trial is determined by interpolating from the first two assumed values.

DONALD N. BECKER,
Bridge Designing Engineer, City of Chicago.
Chicago.

Imposing a Forfeit for Failure to Bid

SIR: The board of trustees of the Alhambra school district, Alhambra, Cal., near Los Angeles, has adopted an effective rule for imposing a fine upon contractors who signify their intention of bidding upon advertised work and, after securing plans and specifications, fail to do so.

A deposit of $25 is now required from every contractor obtaining a set of plans for proposed work, such deposit to be forfeited to the board should the particular contractor fail to tender a bona fide proposal. This deposit is in addition to the one of $10 regularly exacted to insure the proper return of the plans and specifications, as well as the customary 5 per cent certified check or bond required to guarantee the good faith of the contractor in adequately carrying out the contract should he be the successful bidder.

The inauguration and enforcement of this rule has been brought about through the difficulty experienced in promptly complying with all requests from intending bidders for plans and specifications, while the necessary number required for such applications has grown to be a considerable item of cost. Bids received upon different work conclusively show that the board has often been prevented from receiving genuine proposals through the limited number of sets of plans available, and additionally that many contractors frequently hold plans until the last moment and fail to present a bid on the work.

By the method adopted the board is safeguarded to a great degree from the uncertain bidder who secures a set of plans and subsequently neglects to submit a proposal, while the more responsible contractor thus becomes assured of receiving plans for estimating. Equitable treatment is accordingly insured to the board and contractors alike, and far more so to the latter than requiring the purchase of plans outright (usually at an excess cost), as is frequently the case. Results obtained through a few weeks' operation have proved the value and ability of the rule to effect its purpose.

Newark, N. J. L. R. W. ALLISON.